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THE JOURNAL OF MYCOLOGY:

DEVOTED TO THE STUDY OF FUNGI,

ESPECIALLY IN THEIR RELATION TO PLANT DISEASES.

PREPARED, UNDER THE DIRECTION OF THE SECRETARY OF AGRICULTURE,

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CONTENTS.

	Page.
INTRODUCTORY	5
PERONOSPOREÆ AND RAIN-FALL, by B. D. Halsted	6
AN INTERESTING UROMYCES, by B. D. Halsted	11
NEW SPECIES OF KANSAS FUNGI (Plate I), by Kellerman and Swingle	11
A STUDY OF THE ABNORMAL STRUCTURES INDUCED BY USTILAGO ZEÆ MAYS (Plates II to VII), by Etta A. Knowles	14
SYNOPSIS OF NORTH AMERICAN SPECIES OF NUMMULARIA AND HYPOXYLON, by Ellis and Everhart	19
THE GENUS SCLERODERMA IN SACCARDO'S SYLLOGE, by J. B. Ellis	23
SOME NEW SPECIES OF HYMENOMYCETOUS FUNGI (Plate VIII), by Ellis and Everhart	24
TRIBLIDIUM RUFULUM (SPRENZEL), by J. B. Ellis	29
BRIEF NOTES ON A FEW COMMON FUNGI OF MONTANA, by F. W. Anderson	30
SPOTTING OF PEACHES, by Erwin F. Smith	32
EXPERIMENTS IN THE TREATMENT OF GOOSEBERRY MILDEW AND APPLE SCAB, by E. S. Goff	33
NOTES	37, 38
Sulphuret of Potassium for Bitter Rot of Apples.—Bordeaux Mixture for the Plum-leaf Fungus.—A Tomato Disease.	
REVIEWS OF RECENT LITERATURE	39–48
Sclerotium Diseases of Vaccinium Berries (W. Woronin).—Propagation and Prevention of Smut in Oats and Barley (J. L. Jensen).—Preliminary Report on Sorghum Blight (W. A. Kellerman).—Sexual Organs in Æcidium (George Massee).—Perithecia of Black-rot (Prillieux).—Experimental Studies of Vine Diseases (Viala and Ravaz). Parasitic Fungi of Cultivated and Useful Plants (G. Briosi and F. Cavara).—A Lily Disease (H. Marshall Ward).	
DESCRIPTION OF PLATES	48

INTRODUCTORY.

As has already been announced, the JOURNAL OF MYCOLOGY will henceforth be published by the Section of Vegetable Pathology, and will be issued quarterly instead of monthly.

The publishing of this journal is something of a departure from the work ordinarily done by this Section, and has been undertaken for somewhat different purposes.

The growth of the study of Mycology during the past twenty years has been phenomenal, and as it forms the very foundation for that more practical study, the proper means of combating the parasites which are causing such serious losses to cultivated plants, it seems highly proper that the Department at Washington should furnish all the stimulus possible for the prosecution of the study.

The law establishing experiment stations makes special mention of the study of plant diseases. In some stations work in this direction has already been started, and more will probably be undertaken in the near future. The literature on this subject is scattered through many journals and papers in half a dozen languages. It is not, therefore, easily accessible or procurable by the stations, and is altogether out of the reach of many private workers in this field. These and other reasons have made it seem desirable to bring together in some regular publication the latest and best knowledge of mycological experts, together with some account of the most important literature.

From what has been said it is apparent that the aim of this publication will be to reach and assist the workers in this difficult field rather than to prepare matter more directly for the general reader. The latter is already provided for by the issue of bulletins and in various other ways, both by this Department and by the stations themselves.

PERONOSPOREÆ AND RAIN-FALL.

By Byron D. Halsted.

The chief point in this paper is to contrast the prevalence of the *Peronosporeæ* during the past year with the quite general absence of them the two previous years. It will be necessary to state the leading difference in the rain-fall of the last two years, and as this is the only apparent element of variation, except in so far as this modifies other meteorological conditions, it is only natural to attribute the variations in amount of mildew largely to the difference in the rain-fall.

The year 1887 was an exceedingly dry one and the last growing season has been not far from the average one in moisture. In 1887, according to the weather record kept at the college (Ames, Iowa) and kindly furnished me by Professor Osborn, the showers in time and amount were as follows:

	Inches.		Inches.
Mar. 5	.10	July 17	.02
Mar. 27	.56	July 18	.30
Apr. 23	1.26	July 19	1.45
Apr. 26	.02	July 22	.13
May 14	.16	July 30	.41
May 22	.08	Aug. 5	.23
May 29	.15	Aug. 9	.11
June 6	.02	Aug. 10	.08
June 11	.20	Aug. 18	.09
June 12	.43	Aug. 20	.40
June 13	1.16	Aug. 21	.08
June 20	.23	Aug. 26	.10
July 13	.45	Aug. 30	.08
July 16	.02		

By month this gives for—

	Inches.		Inches.
March	.66	June	2.04
April	1.28	July	2.78
May	1.39	August	1.17

This is an average of only 1.39 inches per month and a total of 8.32 for that half of the year when rain is most essential for the existence and growth of vegetation. This prolonged drought was made more intense by the preceding dry year. It was in fact the second of two comparatively rainless seasons. September opened with refreshing showers, and by the close of the month the rain-fall amounted to nearly 10 inches (9.77).

For six months in 1888 the rainy days were as given below:

	Inches.		Inches.
Apr. 26–29	1.22	July 4–5	1.86
May 3-4	1.51	July 16	1.73
May 7–9	1.47	July, scattering (3)	.58
May 27–28	1.11	Aug. 5–6	.37
May, scattering (3)	.46	Aug. 10	.65
June 1	.38	Aug. 14–15	1.38
June 12	.17	Aug. 28	.14
June 20–21	1.19	Sept., scattering (4)	.16
June 27	.66		

By month this gives for—

	Inch.		Inch.
April	1.22	August	2.54
May	4.55	September	.16
June	2.40		
July	4.17	Total	15.04

It will be noticed that while in 1887 there were only three rains of over an inch in the growing season, during the past year the record shows seven. The most marked difference was in May, when 4.55 inches of 1888 stands in contrast with 1.39 inches of 1887. It should be kept in mind that May is the time when rains, if not in excess, do the greatest amount of good, as vegetation then is in a condition to profit most from showers. The amount in June remains about the same, but that for July and August is nearly double. The species of *Peronosporeæ* are taken up one by one, as this seems the best method of exhibiting the contrasts.

PHYTOPHTHORA INFESTANS, DBY. Three years ago, after an average season, there was much complaint of the rot in all parts of Iowa, and housed tubers contained the parasite in abundance. The potato crop for 1888 was very heavy, and no rot has been seen by or reported to me. The two very dry years, viz, 1886 and 1887, doubtless have greatly reduced the number and vitality of the rot spores, and done more than an average season to rapidly develop the rot.

PERONOSPORA VITICOLA, DBY. None of this mildew of the grape was found last year, although the search for it was frequently made, and in places where two years before the wild canes of *Vitis riparia*, were dwarfed and covered with a thick white felt down to the earth's surface. No signs of the mildew could be found in the large college vineyard, where many sorts of cultivated grapes and a few scattered vines of native wild species are grown. The vines were in every way healthy, and flourished when all vegetation about them was suffering with drought and heat. This season the cultivated vines suffered severely from the mildew, and nearly every leaf was more or less affected and the crop much injured.

PERONOSPORA HALSTEDII, FARLOW, is the most wide-spread species in Iowa. Its hosts are numerous, the leading ones of which are several species of *Helianthus*, *Silphium*, *Eupatorium*, *Bidens*, and a long list of other genera all of the order *Compositæ*. In 1886 this mildew was moderately common, but last year it was found only upon those composites which were in wet places. It was rare upon *Helianthus;* not found at all upon *Ambrosia artemisiæfolia*, *Solidago Canadensis*, or *Eupatorium* and *Silphium* species. In short, the genus *Bidens* was the only one which could furnish any considerable supply of specimens. *B. frondosa*, *B. chrysanthemoides*, and *B. connata*, var. *comosa*, all were infested, but these hosts grew in beds of streams where plenty of moisture reached the rank succulent plants. This year there has been a fair quantity of the *Compositæ* mildew upon the high-ground plants, especially about the middle of June, which may be accounted for by the May rains.

PERONOSPORA OBDUCENS, SCHRŒT, upon *Impatiens fulva*, has not been met with during the last three years. It is not a common species in the most favorable season.

PERONOSPORA GERANII, PK., was not found last year upon the common host *Geranium maculatum*, but in May was collected by A. S. Hitchcock upon *Geranium Carolinianum*, at Iowa City. During June of 1888 the mildew was very abundant upon *G. maculatum;* in fact, more so than any other species at that time.

In May last a *Peronospora* was found upon the common water leaf (*Hydrophyllum Virginicum*). I am not aware that Dr. Farlow, to whom specimens were sent, has determined the species. It was growing over the same areas, and closely associated with the Spotted Cranesbill affected with *P. geranii.* It is very interesting to note that the same species was first discovered by Mr. Holway about a fortnight earlier, at Decorah, Iowa, and also found by Mr. Hitchcock, of Iowa City, at almost the same time as at Ames.

PERONOSPORA PYGMÆA, UNGER, on *Anemone* sp., was not observed last year, but in 1888 it flourished in late May and early June.

PERONOSPORA GANGLIFORMIS, DBY., occasionally appeared upon the lower leaves of *Mulgedium leucophæum*, in 1887. The other hosts prefer dry ground, and in their dwarfed condition were not infested. During the year just closed it could be said to be common upon *Prenanthus* and *Lactuca* hosts.

PERONOSPORA PARASITICA, TUL., is one of the most common species upon various cruciferous hosts. In ordinary seasons *Lepidium Virginicum*, is badly infested, having its branches strangely distorted. Last year the pepper-grass was quite free from the parasite, if we except the seedlings, which were attacked for a few weeks in spring. The *Peronospora* was most abundant upon *Nasturtium palustre.* In June the lower leaves of the host, lying close to the moist ground of borders of streams, were quite generally affected. A little later, when the drought had progressed, it was not abundant. In some specimens the conidiophores were not more than one-fourth the normal size. Early in 1888 the mildew was abundant upon the pepper-grass, and continued so until July.

PERONOSPORA POTENTILLÆ, DBY., was common on *Potentilla Norvegica*, early in 1887, when the host was growing on the borders of low wet places. It disappeared as the dry weather of late spring arrived. Last season it did not appear in abundance until July, when whole large plants were found attacked.

PERONOSPORA ARTHURI, FARLOW, was not common three years ago, but during 1886–'87 it was found only on a few plants growing along the shady bank of a stream. It has not been common the last season and is peculiar in only attacking here and there a whole plant.

PERONOSPORA EFFUSA, RABH., is a common species upon *Chenopodium album*, but was far less abundant than usual during the two dry seasons.

PERONOSPORA POLYGONI, THÜM., is rare on *Polygonum dumetorum*. Mr. Hitchcock found the mildew upon *P. aviculare*, at Iowa City in May of 1887, but it was not at all common. It was abundant upon *P. convolvulus* in July of the last season.

PERONOSPORA ALTA, FCKL., has been almost entirely absent from *Plantago major*, for the last three years. In 1885 it was one of the easiest of the Peronosporas to obtain in quantity.

PERONOSPORA TRIFOLIORUM, DBY., has heretofore been one of our most common species upon *Astragalus Canadensis*, and especially on *Vicia Americana*. Upon the latter two years ago it was so abundant as to almost destroy the host in whole patches. It was found in 1887 only after diligent search in the moistest places where the vetch will grow. It again appeared in 1888 but in milder form than before the dry years.

PERONOSPORA EUPHORBIÆ, FCKL., is a species which quickly disappears in times of drought. It is not uncommon on *Euphorbia maculata*, in a wet season, but rare indeed in 1887. The usual amount was met with in 1888 noticeably dwarfing the small leaves of the host.

PERONOSPORA LEPTOSPERMA, DBY., was common in 1885 on both *Artemisia biennis* and *A. Ludoviciana*. During 1887 it was met with in only a few places on *A. biennis*, growing in moist spots near excavations along a railroad track. Last season found it abundant again.

PERONOSPORA SORDIDA, BERK., is a good illustration of the influence of moisture upon the development of *Peronosporeæ*. The host *Scrophularia nodosa* is a common plant on the banks of streams, especially where the surface is without sod. In 1887 the mildew was abundant in only one place—a bend of a stream where the host grew close to the water and could obtain moisture freely. It was not at all uncommon during the last growing season.

PERONOSPORA LOPHANTHI, FARLOW, on *Lophanthus scrophulariæfolius*, is a rare species in Iowa and was met with only in 1887.

PERONOSPORA GRAMINICOLA, SCHRŒT., which was abundant in 1886 upon *Setaria viridis*, transforming the inflorescence of the grass into strange shapes, was far less common during 1887. Last autumn it infested the foxtail quite generally and appeared to some extent upon the Hungarian grass. This new parasite may do much mischief in the future.

PERONOSPORA CALOTHECA, DBY., is not rare upon species of *Galium*. In October, 1887, seedling plants, which had come up in a rich mold since the September rains, were badly infested. This is a good illustration of fresh, growing tissue being favorable for the development of *Peronosporeæ*.

The genus *Cystopus* has four species common to Iowa.

CYSTOPUS CANDIDUS, LÉV., like *Peronospora parasitica*, is confined to the *Cruciferæ*, and also like it lives over the winter within the tissue of the seedling plants. There was an abundance of the *Cystopus* on Shep-

herd's-purse seedlings in the spring of 1887, and it produced a large crop of spores which did not spread the trouble rapidly to other plants as in an ordinary season. In June there was very little of the mildew and only a few spots could be seen on the seedlings in the autumn. Only a small amount of the fungus was found the next spring. The mildew was fairly abundant upon the common pepper grass (*Lepidium Virginicum*), but soon disappeared. Three years ago in a moist season the blossoms, flower stalks, and seed vessels of the garden radish were generally attacked and often distorted beyond recognition. Very late in October, 1887, the mildew was found prevalent upon seedling plants of *Sisymbrium officinale*, which had developed after the September rains in a shady place. Last year there was very little of the mildew upon the Shepherd's-purse. The two dry years had done much toward eradicating it along with the host.

CYSTOPUS CUBICUS, LÉV., is the least common species of the genus, and for the last three years has been found upon *Ambrosia artemisiæfolia, C.*, only at rare intervals.

CYSTOPUS BLITI, LÉV., occurs upon an increasing list of hosts. *Amarantus blitoides*, was badly infested in all three seasons, and as this species flourishes in dry places, upon paths, and roadways it at first seems an exception to the rule. However, this Amaranth is thick-leaved and succulent, and like the purslane is full of moisture, even though the surroundings are arid. It was a fact of observation that the greatest development of the mildew was upon plants which were most favored with moisture and shade.

CYSTOPUS PORTULACÆ, LÉV., is the last species of the list and one of no little interest in the present connection. It seems to have been more abundant during the two dry seasons than before or since. The host is a juicy plant and the appearance of greater thrift on the part of the parasite may be due to the fact that it was more than usually destructive, the purslane not being able to withstand its attacks. Therefore a patch of the host while showing more of destructive effects of the mildew might in fact have less of the parasite. It is impossible to say there was more or less of the mildew the last year than the season preceding. These observed facts seem to show that with the *Peronosporeæ* there is no doubt that the species are best suited to a moist season. The members of the genus *Peronospora* have in no instance been so abundant during the two dry years as before or since the drought. In general the mildews were found in early spring in 1887, after this, through the long dry summer, in limited quantities, upon plants growing in moist places along streams and edges of pools. In 1888 the greatest abundance was in June after the May rains.

The genus *Cystopus* seems less influenced by drought, but as a rule the infected specimens were those best situated for obtaining moisture. In all cases where *Peronosporeæ* flourished in drought, they were upon succulent hosts, and even with these there was probably less growth of

parasite but a greater manifestation of disease due to lack of vitality in the hosts. These instances, therefore, form no exception to the general rule, that dry weather is not advantageous for the development of the *Peronosporeæ.*

In preparing this paper the writer has drawn freely upon his article "Downy Mildews in a dry Season" in Ames' (Iowa) College Bulletin, 1888, which gives an account for the years 1886 and 1887, and in some instances the form of statement therein used is here reproduced.

AN INTERESTING UROMYCES.

By BYRON D. HALSTED.*

The following description is of a *Uromyces* collected the past autumn, which has the habit of infesting the perigynia of a sedge, causing them to assume a quite unnatural dark color before their time of maturing.

UROMYCES PERIGYNIUS, HALSTED. Sori one-half to 2^{mm} in diameter, forming dark-brown, nearly globular patches upon the outside and between the veins of the perigynia, not infrequently upon both surfaces of the younger leaves, where the patches are often three times as long as broad. Teleutospores somewhat variable, 4–6 by 8–10μ, with a prominent brown free end ranging from acute to wedge shaped. Contents usually granular and often with a large oil globule. Pedicel two to three times the length of the spore, slender and hyaline.

On *Carex intumescens*, near Ames, Iowa, September, 1888. D. G. Fairchild.

The other known species of *Uromyces* upon *Carex* is *U. Caricis* of Peck (Mycotheca Universalis No. 746), which is very different in habit and characteristics of the spore. It is reported only upon *Carex stricta* and not upon the perigynia. In making the comparison it was interesting to observe that with *U. Caricis, Pk.*, there were ocasional double spores among those of normal form. Sometimes a half dozen adjoining spores in a partially crushed sorus would be of the puccinia type. Those who are subscribers to Ellis and Everhart's N. A. F. may expect the *Uromyces* above described in the next issue.

NEW SPECIES OF KANSAS FUNGI.

By W. A. KELLERMAN and W. T. SWINGLE.

TILLETIA BUCHLOËANA *n. s.* In the much enlarged and mostly globular ovaries of *Buchloë dactyloides*, abnormally borne on the male plants; often all or nearly all the staminate spikelets produce the ovaries, all of which are infested. Spores dirty brown in mass, as seen

* Rutgers College, New Brunswick, N. J.

singly dusky or brownish fuscous, never very dark, perfectly spherical or very slightly oval, regular in size, $16\frac{1}{2}$–21μ diam., but mostly 18–20μ (exclusive of hyaline envelope). The outer wall of the spores is marked with scattering, regular spines or faint reticulations (formed by coalescence of the spines?) $\frac{1}{2}$–$1\frac{1}{2}\mu$ high, but completely enveloped by the outer hyaline layer, which is $1\frac{1}{2}$–4μ thick. The outer wall is about $1\frac{1}{2}$–2μ thick, and is the darkest colored part of the spore; immediately within this is a thinner, clear, lighter colored wall $\frac{3}{4}$–1μ thick; following this is a layer of variable thickness, usually finely but sometimes coarsely granular. In the center of the spore is a very light homogeneous usually spherical body 7–10μ, mostly $7\frac{1}{2}$–9μ in diameter.

On male plants of *Buchloë dactyloides*, western and southwestern Kansas (Trego County, 1886, and Ford County, June, 1888).

In some cases, especially in young spores, the hyaline layer is seen to be made of two distinct layers, the inner extending from the wall to the tips of the spines and being slightly darker than the outer layer. The immature spores when placed in water become very much swollen and are almost colorless, except the collapsed central body. Mixed with the spores were seen in many cases a hyaline, branched, septate mycelium, 3–$4\frac{1}{2}\mu$ diam., but whether connected with the spores or not can not be said. Attempts to induce germination of the spores failed.

The infected plants are easily detected by their apparently denser and darker inflorescence, but the monstrosity consists solely in the production of ovaries in the male plants. These are in every case filled with the mass of spores and are very much enlarged pushing the glumes wide apart. In size the smutted ovaries are 1.3–1.8 by 0.6–1.3^{mm}. The few female plants collected in the same localities were free from the fungus. Figs. 1–11.

USTILAGO ANDROPOGONIS, *n. s.** In the ovaries of *Andropogon provincialis* and *A. Hallii*, not only the sessile flowers (which are perfect), but also the pedicelled ones, which are normally staminate, often produce the cylindrical elongated infested ovaries; spores in mass intensely black, as seen singly dark brown or black, subglobose or slightly oval, sometimes oblong elliptical or ovate, slightly angular. Wall thick ($\frac{3}{4}$–2μ, mostly $1\frac{1}{2}\mu$) very finely and closely echinulate. Contents coarsely and evenly granular or sometimes homogeneous, 12–19μ by $9\frac{1}{2}$–16μ, mostly $13\frac{1}{2}$–$15\frac{1}{2}\mu$ by 11–14μ.

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* Since sending the description of this species to the printer we have received Ellis & Everhart's North American Fungi Cent. XXIII. No. 2265 *Sorosporium Ellisii.* var. *occidentalis*, on *Andropogon furcatus*, Bismarck, Dak., August, 1884, A. B. Seymour, is the same as *Ustilago andropogonis*, Kell. & Sw. The Dakota specimens were examined by us as were the youngest Kansas specimens (collected June 26, 1888) but in none could the spore masses characterizing *Sorosporium* be seen. Besides, the spores are larger and different in color, shape, thickness, and character of wall, number and size of spores, etc., from *Sorosporium Ellisii.* The species as far as can be determined without a knowledge of the germination of the spores certainly seems to be a good *Ustilago.* No. 2265, *b.* N. A. F. on *Andropogon Virginicus*, Newfield, N. J., is apparently different from the above and a true *Sorosporium.*

The spores found on *Andropogon provincialis* are somewhat narrower and longer than on *A. Hallii*, and more often oval than subglobose. They were also more variable in size and shape. On *A. provincialis* the spores were 12–19 by 9½–13½μ, mostly 13–16 by 10–13½μ, while on *A. Hallii* they were 13–18½ by 11–16μ, mostly 13½–15 by 13–14μ. Attempts to induce germination failed.

Southwestern Kansas, June, 1888. On *Andropogon Hallii*, Seward County, June 26, and on *A. provincialis*, Harper County, July 14, 1888. The affected ovaries on *A. provincialis* are 2.5–7 by 1.2–8^{mm}, and those *A. Hallii*, 6–8 by 1.4–8^{mm}.

This species is clearly distinct from *Ustilago Ischaemi* Fckl., and *U. cylindrica*, Pk. both in size of spores and in being confined to the ovaries. Figs. 12–26.

USTILAGO BOUTELOUÆ *n. s.* In the enlarged ovaries of *Bouteloua oligostachya*; spores in mass, brownish; when seen singly, dark brown or sometimes light brown, oval, subglobose, or elliptical, regular or sometimes slightly angular; wall thin (about ½μ) irregularly, rather sparingly, tuberculate–echinulate (spines short, 1½–3μ apart); contents homogeneous or often containing a single large granule, 8–12 by 6–10μ, mostly 8½–10 by 8–9½μ. Germination in water by means of a septate promycelial tube bearing one or two elongate cylindrical sporidia just below the septa at the end. Promycelial tube simple or rarely branched, hyaline, 2–4 septate, 25–50μ by 2–4μ. Sporidia cylindrical, ends subacute, hyaline, 9–13μ by 2–2½μ.

Mixed with the spores in some cases were seen hyaline bodies of varying sizes composed of cells somewhat smaller than the spores, arranged in a sublinear manner. The spores germinated readily in water at a temperature of 37° C. and the promycelial tubes often separate readily from the spores when they have attained their growth. The sporidia were observed budding in a few cases.

On *Bouteloua oligostachya*, Manhattan, Kans., autumn and winter, 1888. In many cases the affected plants could be detected at a glance, as the spikelets were retained long after they had fallen from the healthy plants. The smutted ovaries are 1.5 – 4.6 by 0.8 – 1.7^{mm}.

The grasses attacked by the three preceding species of fungi are important for the West. They furnish a very large part of the pasturage, and even a considerable portion of the hay crop. The smuts, preventing the formation of seed, will therefore, when abundant, likely do damage of much consequence.

ÆCIDIUM DALEÆ *n. s.* Spots none; æcidia on the leaflets or rarely on the petioles, mostly hypophyllous but often also sparingly epiphyllous, numerous, crowded, occupying from a third to the whole of the leaflet, which becomes yellowish in color as far as attacked. Peridia white (or pinkish?), usually slender ($\frac{1}{5}$–$\frac{1}{3}$^{mm} diameter), of moderate length ($\frac{1}{6}$–$\frac{1}{3}$^{mm}), cylindrical or very often constricted above, open from the first, never hemispherical; margin crenate, subentire, or crumb-

ling or lacerated into many short erect or slightly reflexed segments. Peridial cells, below small and polygonal, above very large and having a flattened conical portion projecting outward and upward from the inner side, sometimes containing a few yellow granules, 18–42 by 15–36μ, wall 2–5μ thick, conspicuously tuberculate, the warts forming short lines or clusters on the surface. Spores yellow or at length pallid, subglobose or oval, regular or slightly angular, 23–32 by 18–25μ, mostly 24–28 by 21–24μ, wall 2–4μ thick, marked with both very fine warts and short, very blunt, round tubercules 1–2μ in diameter, which are wanting on the two attached surfaces but extend around the spore in a band, becoming closely crowded midway between the attached surfaces. Spermogonia amphigenous, scattered, immersed, globose or flask shaped, about 100μ in diameter, scarcely visible except in section.

On *Dalea laxiflora*. Rockport, Rooks County, Kans., June 12, 1888, E. Bartholomew, No. 228.

This is a peculiar and well-marked species. The upper peridial cells on the inner surface overlap somewhat like the scales of a fish, but also project outward. They are also remarkable for their great size. When the æcidia occur on the petioles they cause an enlargement, but on the leaflets scarcely any thickening can be observed. Mr. Bartholomew remarks that the species is "very abundant, making many of the host plants entirely abortive."

A STUDY OF THE ABNORMAL STRUCTURES INDUCED BY USTILAGO ZEÆ MAYS.[1]

(Plates II, III, IV, V, VI, VII.)

By Etta L. Knowles.

The fungus known as *Ustilago Zeæ Mays* is found on Indian corn everywhere. It appears in stem, leaf, grain, and in both staminate and pistilate flowers, producing an abnormal growth of tissue sometimes as large as a man's fist, whitish at first but black when the spores ripen, which is about the time of the ripening of the corn.

In order to understand the changes which are produced by the fungus, a careful study was at first made of the normal structures. Alcoholic material gathered July 19, 1887, was used for this purpose and also for the study of the abnormal structures. Schulze's solution was used for staining the sections and glycerine for mounting them. The drawings were all made with a camera and are on the same scale.

Upon examining the stem it was found to consist of an epidermal system and scattered fibro-vascular bundles, of a somewhat oval form in cross section, between which were the rather large cells of the ground

[1] This work was carried on under the direction of Prof. V. M. Spalding, in the botanical laboratory of the University of Michigan, 1888.

tissue. The latter were hexagonal in cross, and rectangular in longitudinal section, Figs. 1 and 2. Their walls are rather thick and contain numerous thin places which are elliptical in form and lie with their long axes perpendicular to the axis of the stem. Many of these seem to have broken through and formed openings from one cell to the next. The intercellular spaces are small. The size of these cells varies with their position, those midway between two bundles being larger than those immediately adjacent to them.

The bundles are scattered through the ground tissues at somewhat regular intervals, always with the phloëm turned toward the epidermis. Near the periphery of the stem they are packed more closely together, with very little of the ground tissue between, Fig. 3. They are of the form known as the closed collateral bundle. Within the xylem and toward the inner side of the bundle is a space, Fig. 4, *a*. Partially surrounding it is the xylem parenchyma, which is composed of small elements with thinner walls than are found in the adjacent tissue. Back of this canal and partially projecting into it is an annular vessel, *b*. At each side of the bundle is a large duct, *c*, with thick reticulated walls. Between the ducts and back of the annular vessel are thick-walled elements, the tracheides. Between the tracheides and ducts and the external part of the bundle is the phloëm *d*, consisting chiefly of sieve tubes and cambiform cells. The latter, small, thin-walled, square, or rectangular, sometimes narrow or obliquely four-sided elements, are distributed among the sieve tubes, which are rather large, thin-walled, polygonal elements. Both sieve tubes and cambiform cells are filled with a granular protoplasm. The elements of the bundle sheath *e* have thick pitted walls. It is developed best at the ends, particularly at the outer end, where it may consist of several layers. At the sides it often borders directly on the ducts. In longitudinal sections, Fig. 5, all of the elements are found to have transverse septa, except those of the bundle sheath, in which they are oblique. The sieve tubes are longer than the cambiform cells, and have the characteristic callous plates. The annular vessels are seen to consist of a very thin-walled portion, which is held open by thick rings placed at nearly regular intervals, *g*. The bundles just under the epidermis are usually somewhat different from those just described in that the larger intercellular space is partially or wholly absent.

The epidermis is made up of cells, which are represented in cross section in Fig. 3, *a*, in longitudinal section in Fig. 6, *a*, and in surface view in Fig. 7, *a*. As seen in the two latter they are elongated cells with slightly sinuous outline and thick pitted walls, the outer of which is somewhat the thicker and covered with a thin cuticle. In longitudinal sections and in those which show surface views there are seen to be two kinds of cells, those already described and short cubical cells. The latter are found usually one at each end of a long cell, but sometimes there are several of them together. The sub-epidermal tissue consists of

several layers of sclerenchymatous elements, Fig. 3, *b*, which are similar in appearance to those of the bundle sheath. Numerous stomata were found, each consisting of two guard cells, Fig. 7, *b*, and a pair of accessory cells, *c*. In surface view the former are dumb-bell shaped, fitting closely together at their ends, while the latter are nearly semicircular in outline.

Sections were then taken of a diseased portion of the same stem, of which the normal structure had been studied. The abnormal growth forms a more or less elongated mass at the side of the stem. Fig. 8 is a digrammatic representation of a cross section through a diseased portion, *b*; *a* represents the stem and *c* the outgrowth from it. The part of the stem at *b* seems to be little changed in structure, but at *a* quite the reverse is seen. At the latter point the bundles especially were very much distorted, being swollen to several times their normal size through cell multiplication, and in longitudinal section those lying adjacent to *c* were seen to be sending numerous small branches into it. Getting a very early stage, Fig. 9, the first change noticed was a separation of the epidermis, together with its two or three layers of sub-epidermal tissue, *a*, from the parts lying directly underneath, by one or two layers of cells, *b*, similar to those of the ground tissue and containing starch grains. In the normal stem examined the sub-epidermal layers were so closely connected with the bundle sheath of the peripheral row of fibro-vascular bundles that no line of division could be traced separating the two. Taking sections where the distortion was in all grades of development, it was found that as the abnormal tissue developed this space increased, until, instead of one or two layers of cells, as at first, there was a mass of cells separating them, thick walled in early and thin walled in later stages. The walls of the epidermal cells also became thin. For the most part, then, the abnormal tissue appears to grow in between the epidermal system and the outer row of fibro-vascular bundles, the latter taking part to the extent of sending into it numerous branches. In order to accommodate this great increase of tissue, the epidermal cells stretch and divide and change their form from that seen in Fig. 7 to that seen in Figs. 10 to 14.

The stomata are distorted in the manner shown in Figs. 11, 12, 13, and 14. An attempt was made to trace the changes which take place in the accessory cells from the normal form seen in Fig. 7 *c*, to the distorted form represented in Fig. 14 *b*. Fig. 14 was from a section cut from a place where the spores were nearly ripe, while Figs. 11, 12, and 13 were taken from the surface of tissue which was not so well developed, and represent three forms intermediate between the normal form Fig. 7 and the distorted form Fig. 14.

The cells of the ground tissue were found to be different in form according to their position. Those in the region of active growth, that is, in the region adjacent to the normal part of the stem, Fig. 8 *d*, were seen to be of the form of those represented in Fig. 15, very thin-walled,

the long axes of the cells lying parallel to a tangent drawn to the nearest point of the original stem. Each was completely filled with material for growth. Passing farther out this form gradually changes first to that represented in Fig. 16, then to a form like those in Fig. 17, then to smaller cells again, and covering all the epidermal cells, as shown in Fig. 18. The cells described above all had thin walls, without pits or openings. In most of them the nucleii were very large and conspicuous, especially in those represented in Fig. 18. Abnormal fibro-vascular bundles ran through the tissue, and adjacent to them the cells of the ground tissue were elongated in the direction of the length of the bundle.

In Fig. 19 a bundle is represented in which the distortion has not been carried very far. It has become a little broader by cell-multiplication, and the xylem parenchyma and tracheides as well as all of the phloëm have become very thin-walled, and give the reaction for cellulose with Schultze's Solution. In the normal structure the two former were composed of liquefied elements. Large nucleii were observed in a great many of the cells of the xylem parenchyma and in one or two cases in the sieve tubes. The cells of the bundle sheath have multiplied at both ends of the bundle, and in a more distorted bundle than the one represented were seen to also have become thin-walled. In stages a little farther on, cells which looked like those of the ground tissue, and which were filled or partially so with starch, had grown in and separated the bundle into little groups or bundles of thin-walled cells. These branches passed out into the abnormal growth, and these branched again, forming altogether a sort of tree-like organ for the support and nourishment of the delicate tissue through which it runs. Figs. 20 *a* and 21 show longitudinal sections of the bundles as they appear in this tissue. They are composed of short, narrow, thin-walled cylindrical cells, arranged end to end. Nucleii are conspicuous in most of them, and all are filled with a finely granular substance which colors yellow with Schultze's Solution. In Fig. 21 the bundle has thrown off a slender branch at *a*. The walls of these cells had no markings, and the cells themselves appeared very much like cambiform cells, except that they were shorter, and contained conspicuous nucleii. In the normal tissue nucleii were not observed in either sieve tubes or cambiform cells. In some of the bundles similar to those figured in 20 and 21 there were one or two layers of cells at each edge of the bundle which were small and thin-walled, but showed reticulated and pitted markings. In Fig. 22 a cross section of one of these bundles is represented. In them the elements are so changed that phloëm can not be distinguished from xylem, and there are no large elements. Where the large pitted ducts run into the abnormal tissue, which usually they do not, they take a course separate from the bundles and have very grotesques forms, changing direction constantly.

The observations made upon the fungus which causes these changes

agree with the descriptions which have been repeatedly given of it. It consists of a thick-walled mycelium tube, the lumen of which is not constant in diameter, but in some places widens out and in other places is almost or apparently quite closed. The thickness of the mycelium filament also varies constantly. These coarse, tough threads are found in different parts of the stem, some at the center, others nearer to the periphery, running between the cells or into them, and with their sharp end pushing directly through the thickest walls, Fig. 24.

In fruiting, the mycelium forms a great number of short slender branches. Great masses of these are found in little nests in the abnormal tissue, Fig. 20, also Fig. 8. They are more slender and delicate than the mycelium already described and are generally of quite irregular form. Fig. 23 represents a much branched mycelium filament, which appeared in a break in a section. It appeared to have pushed its way in between the cells and not to have penetrated them. The slender filaments of these masses swell up into a form like that represented in Fig. 25, except that in many cases—indeed in most cases—the filaments lose their individual form and are more or less blended in a gelatinous, shapeless mass. Rounded places with little masses of rich protoplasm, Fig. 25 *a*, indicate spores in an early stage of formation. All stages may be found in the same mass. Fig. 26 shows later stages, where the ends of the filaments appear club-shaped and within are seen the almost ripe spores. The mature spore, Fig. 27, is one celled with two walls; the outer thick, brown, and covered with spines. The inner delicate and transparent.

From the comparatively small number of species in which abnormal changes under the influence of parasitic fungi have been carefully studied, it is hardly possible as yet to venture on any general or theoretical statements concerning the pathological changes induced by such parasites. It seems best therefore, in the present instance, to simply recapitulate the injuries occasioned to the host by the fungus in question, since it is only by multiplied observations of the same kind that sufficient data can be gathered for a more general conception of the relations of parasite and host.

The changes observed in the stem of *Zeæ Mays* are briefly as follows:

An extraordinary hypertrophy of the parts of the host where spore formation takes place, the irregularity of which gives rise to peculiar and conspicuous distortion.

Microscopic examination shows: (1) Great multiplication of cells near the periphery; (2) decrease in thickness of cell walls and, in case of the bundles, of the size of the elements; in many cases a decrease in the size of the cells of the ground tissue also; (3) distortion of the stomata, particularly of the accessory cells, (4) a breaking up of the bundles and a changing of their elements, so that in many cases phloëm can not be distinguished from xylem; (5) a marked increase of cell contents.

SYNOPSIS OF NORTH AMERICAN SPECIES OF NUMMULARIA AND HYPOXYLON.

By J. B. Ellis and Benj. M. Everhart.

[Continued from page 113, Vol. iv.]

Nummularia. Tul. Sel. Carp., ii, p. 42. Stroma orbicular, cup-shaped or discoid, becoming black, marginate, the margin more or less distinctly sterile. Perithecia monostichous, peripheric, immersed. Asci cylindrical, 8-spored. Sporidia uniseriate, subelliptical, continuous, dark. The genus is too closely allied to Hypoxylon, especially the discoid forms.

A.—STROMA, CUP-SHAPED OR CONCAVE.

Nummularia discreta (Schw.), Tul. Sel. Carp., ii, p. 45 *Sphæria discreta*, Schw., Syn. N. Am., 1249. On dead branches and trunks of *Pirus Malus* and *Amelanchier Canadensis*, Newfield, N. J., on the first-named host, New England (Farlow), New York (Peck). On *Gleditschia triacanthos*, Ohio (Morgan), found also (Sacc. in Syll.) on *Sorbus*, *Ulmus*, *Cercis*, and *Magnolia*. Stroma erumpent, orbicular, 2–4^{mm}. diameter; cup-shaped, with a thick raised margin; dirty cinerous, then black, the concave surface at first white-punctate from the minute punctiform ostiola which in the mature state are scarcely visible. The wood beneath the stroma is marked with a black circumscribing line. Perithecia monostichous, ovate-cylindrical, nearly 1^{mm}. long, rather abruptly contracted above into a short neck, their rounded bases penetrating to the bottom of the stroma. Asci cylindrical, 110–120μ by 10–12μ. with long filiform paraphyses. Sporidia subglobose, nearly hyaline at first, finally opaque, 10–12 diameter. Sec. Cooke, Grev. xii, p. 6, the specimen of *Sphæria discincola*, Schw., in the Kew Herbarium, figured by Currey in Linn. Trans. 1858, Pl. 47, fig. 105, does not differ from *S. discreta*, Schw., but the *S. discincola* Schw. in Syn. Car. No. 63, and in Fr. S. M., p. 368, appears to be different, as may be inferred from the following description taken from Fries.

S. discincola Schw., Syn. Car. No. 63. Emersed-superficial, perithecia globose, crowded, black, truncate-annulate, covered with a cinereous white furfuraceous coat. Stroma irregular, subrotund, rugose, thin, penetrating deeply into the blackened wood. Perithecia scattered, rather large, urceolate, narrowed above into a minute round mouth, which is closed by white farinaceous matter. On the cut surface of trunks of apple trees in Carolina; rare.

Nummularia repanda (Fr.), *Sphæria repanda*, Fr. S. M., ii. p. 346 *N. pezizoides*, E. & E., Bull. Torr. Bot. Club, xi, p. 74. On bark, Ottawa, Canada (Macoun.), on bark and wood, Topeka, Kans. (Cragin), and on bark of *Ulmus Americana*, Missouri (Demetrio). Found in Europe on branches and trunks of *Sorbus aucuparia*. Stroma erumpent-

superficial, orbicular, or subelliptical, $\frac{1}{2}$–1^{cm}. diam., concave, and often with a thin, erect, rather broad margin, rufo-cinereus at first, finally black; disk mammillose from the projecting ostiola. Perithecia monostichous, immersed, ovateoblong $\frac{1}{2}$–$\frac{3}{4}\mu$, long, crowded, often subangular from mutual pressure. Asci cylindrical, subsessile, 8–spored, 110–120μ by 8μ, with long filiform paraphyses. Sporidia obliquely 1 seriate, narrow ovate, obtuse, subinequilateral, dark brown, 11–14μ by 4–5μ (15–16μ by 6–7μ, Sacc. in Syll.). Distinguished from *N. discreta* by its mammillose disk and differently shaped sporidia.

NUMMULARIA EXCAVATA,* (SCHW.), Syn. N. Am. 1250. On bark of different species of *Prunus*, Bethlehem, Pa. (Schweinitz). Rather rare. Elliptic-orbicular, 1–2^{cm}. across, surrounded and margined by the raised but not radiately fissured epidermis. Disk deeply concave, black, punctulate, with many minute scattered depressions, in the bottom of which are the ostiola. The stroma is included in a peculiar black cup-shaped receptacle, which penetrates to the wood, and is filled in the lower part with a woody pseudo-stroma (altered substance of the bark), the upper part being the true stroma, in which nestle the rather large pyriform scattered perithecia, occupying the central part and attenuated above into a black shining neck. Sporidia short elliptical, dark brown, 11.5–015.3 by 009.6–001.5μ. Allied to the preceding species, but more rare.

NUMMULARIA SUBCONCAVA, (SCHW.), *l. c.* 1251. On branches of *Viburnum dentatum*, Bethlehem, Pa. (Schweinitz). Gregarious and often confluent, erumpent $\frac{1}{4}$–$\frac{3}{4}^{cm}$ across, surrounded by the ruptured epidermis, and consisting of a black crustaceous shell, inclosing the few rather large globose-depressed perithecia, connected by a very scanty stroma. Disk subconcave, subrugose, and black. Ostiola globose-papillate, elevated, few, black, sometimes confluent, connected by a very short neck with the perithecia, which have the ascigerous nucleus white. Sporidia oblong, light yellowish-brown, 15.3–019.2 by 005.76–007.6μ, some of them slightly constricted in the middle but not septate.

B.—STROMA CONVEX.†

NUMMULARIA BULLIARDI, Tul. Sel. Carp. ii, p. 43. *Hypoxylon nummularia*, Bull. Champ. tab. 468, fig. 4. *Sphæria clypeus*, Schw. Stroma at first covered by the epidermis, soon emergent, almost superficial and free, convex, orbicular or oval, rarely of irregular shape, sometimes broadly effused, black inside and outside, punctulate from the slightly

*We are indebted to our friend W. C. Stevenson, jr., who furnished the measurements of the sporidia in this and the next species, from an examination of the original specimens in the Schweinitzian Herbarium in the Academy of Natural Sciences in Philadelphia.

† Were we to rewrite this synopsis we would leave this section (B) of Nummularia in Hypoxylon, where it was formerly included, the difference being too slight to have any real generic value.

prominent ostiola, clothed at first with the rufo-ferrugineous conidial layer. Perithecia rather large, ovate, black, loosely included in closely packed cells in the stroma, something as in *Daldinia concentrica*. Asci cylindrical, briefly pedicellate, 100–115 by 10μ, with very long and stout paraphyses. Sporidia uniseriate, elliptical, hyaline at first, soon opaque, 12–15 by 7–9μ. The hymenium in this species, as in *Hypoxylon Petersii* B. & C., is at first covered by a carnose-coriaceous membrane, which soon disappears, except around the margin. Common on dead trunks and limbs of various deciduous trees around Newfield, N. J. Mostly confined to dead oak. Sec. Cooke in Grev. XII, p. 4, *Sphæria clypeus*, Schw. is different, but Schw., in his Syn. N. Am., gives *S. clypeus* as a syn. of *S. nummularia*, and there is nothing in his herbarium at Philadelphia to show that they are distinct.

NUMMULARIA GLYCYRRHIZA, (B. & C.), *Hypoxylon glycyrrhiza*, B. & C. Exot. Fungi Schw., p. 285. Suborbicular, margin thin, center subpulvinate, and marked with papilliform points (ostiola), which are depressed in the center. Perithecia oblong. On bark, Surinam, South America. Stroma pulvinate, 25 by 12^{mm}. Differs from *N. Bulliardi*, to which it is closely allied, in its oblong closely packed perithecia. The foregoing is the description of this species given in Sacc. Sylloge. We have seen no authentic specimen of this but one sent from Ohio (Morgan No. 284), supposed to be this, was submitted for determination to Dr. Cooke, who was inclined to regard it as this species. In the Ohio specimen the perithecia are a little over one-half millimeter long and are rather narrower than those of *N. Bulliardi*. The ostiola also are rather less prominent and are mostly slightly collapsed. The spordia are oblong, pale brown, 2-nucleate, 10–11 by 4–5μ.

NUMMULARIA OBULARIA, (FR.) *Hypoxylon obularium*, Fr. Nova Symb., p. 130. "Immersum, erumpens, demum late effusum, determinatum, impolitum, stromate proprio atro, peritheciis immersis oblongis, ostiolis hemispherico-prominulis umbilicatis. Ad truncos arborum mortuos in Costa Rica, Oersted." Closely allied to *N. Bulliardi*, Tul., but differs in having its stroma connate with the matrix and inseparable from it, at first subrotund, then concrescent in a continuous crust, generally elongated; and ostiola depressed. The specimens examined by Fries were old and no trace of asci or sporidia remained. Cooke in Grevillea places this species in the preceding section, but there is nothing in the description to show that the surface of the stroma is concave.

NUMMULARIA MICROPLACA, (B. & C.). *Diatrype microplaca*, B. & C. Journ. Linn. Soc. x, p. 386. On *Sassafras officinale*. South Carolina (Ravenel) and Ohio (Morgan 261 and Kellerman 279). On *Persea*, Darien, Ga. (Ravenel F. Am. 255), *Anthostoma microplacum* (*B. & C.*) Sacc. in Syll. Stroma much the same as in *N. hypophlæa*, orbicular $\frac{1}{2}$–1^{cm} across, or elongated 1–2 by $\frac{1}{2}$–1^{cm}, thin, crustaceo-carbonaceous, black originating beneath the epidermis but soon bare, surface even, faintly punctulate from the minute ostiola, which are not prominent but slightly

depressed, as in *Hypoxylon punctulatum*, the opening at first filled with white farinaceous matter. Perithecia ovate-globose, small (less than one-half millimeter), monostichous. Asci (p. sp.) about 25 by 3μ, or with the short base $45–50\mu$ long. Sporidia uniseriate, ends mostly slightly overlapping, sub-inequilaterally elliptical pale brown, $4\frac{1}{2}–5$ by $2–2\frac{1}{2}\mu$. Berkeley says *N. hypophlœa* has lårger ostiola and narrower sporidia. This is true as to, the ostiola, but as regards the sporidia the case is exactly the opposite. The wood beneath the stroma is stained with the same olive yellow color as the next species to which this is closely allied, but differs as stated.

NUMMULARIA HYPOPHLÆA, (B. & RAV.) Grev. IV, p. 95, *ibid.* XII, p. 7. *Anthostoma hypophlœum*, Sacc. On dead trunks of *Magnolia glauca*, Newfield, N. J. (Ellis), South Carolina (Ravenel). Stroma thin, suborbicular $\frac{1}{2}–1^{cm}$ across, slate color, originating beneath the cuticle, which is soon thrown off, slightly convex, and faintly papillose from the slightly projecting ostiola. Stains the subjacent wood yellowish or yellowish olive. Perithecia in a single layer, ovate-globose, small (one-half millimeter), abruptly contracted above into a slender neck piercing the superficial carbonaceous layer of the stroma. Asci slender (100 by 4μ) with a thread-like base (p. sp. $55–60\mu$ long). Sporidia uniseriate, lying mostly end to end, narrow, elliptical, pale brown, 2 nucleate, about 7 by $2\frac{1}{2}–3\mu$.

NUMMULARIA RUMPENS, CKE. Grev. XII, p. 8. *Diatrype rumpens*, Cke. Ann. N. Y. Acad. Sci., I, p. 185. On bark, Galveston Bay, Texas (Ravenel). Orbicular or elliptical $\frac{1}{2}–1^{cm}$ in diameter or by confluence 2^{cm} or over, and then more or less irregular in shape, thin, black, surrounded by the ruptured epidermis, roughened by the slightly prominent ostiola. Perithecia monostichous, ovate, $\frac{3}{4}$ millimeter high. Asci cylindrical, 100–115 by 10μ. Sporidia uniseriate, hyaline, then opaque, elliptical, with ends sub-acute or rounded, 12–15 by $7–9\mu$. This description is drawn from the specimens in Rav. F. Am. This seems to differ from *N. Bulliardi* in its less prominent ostiola and rather more acutely pointed sporidia ; nor are there in the specimens we have seen any very perceptible remains of the overlying membrane. In our collections are specimens of what appears to be the same as those in F. Am. from British Columbia and Louisiana, as well as several of the original Texas specimens from Dr. Ravenel.

NUMMULARIA EXUTANS, CKE. l. c. Broadly effused, black, sub-cuticular, soon erumpent, thin (about one-half millimeter) papillose from the slightly prominent ostiola. "Two or three inches long, with an irregular outline, thinner than *N. rumpens*." Perithecia monostichous, depressed globose, less than one-half millimeter in diameter. In our specimen of this species from Dr. Ravenel, from his Texas collection, the asci had disappeared. The free sporidia were acutely elliptical or almond-shaped, rather variable in size, 10–15 by $6–8\mu$. Cooke says "ostiola depressed." In Ravenel's specimen they were as noted above; presenting the same

appearance as those of *N. rumpens*, from which this appears to differ in its more broadly effused, thinner stroma and depressed globose perithecia.

NUMMULARIA SUBAPICULATA, E. & E. (n. s.). On bark. Topeka, Kan. Cragin 267. Subcuticular, erumpent 1–2^{cm} across, convex, 1^{mm} thick or a little more in the center, with the sterile margin thinner. Ostiola slightly papillose, prominent as in the two preceding species. Perithecia monostichous, oblong, about three-fourths millimeter high, closely packed and more or less laterally compressed. Asci cylindrical, 90–100μ (p. sp.), with a short stipitate base, and with long stout paraphyses, as in *N. Bulliardi*. Sporidia uniseriate, oblong-navicular or inequilaterally-elliptical, pale yellowish brown, 12–16 by 5–7μ, mostly with a single nucleus and a faint, bead-like apiculus at each end. This was reported to Professor Cragin as *N. Bulliardi* Tul. It differs from that species as noted.

THE GENUS SCLERODERMA IN SACCARDO'S SYLLOGE.

By J. B. ELLIS.

This genus in Vol. VII, Part I, of the Sylloge appears to be made up of heterogeneous materials, being made to include not only the species usually known as *Scleroderma*, with a thick, corky peridium, but also species with papery-membranaceous peridium, heretofore included in *Bovista* and *Mycenastrum*. Among the latter we find *Mycenastrum Oregonense*, E. & E. This species was already sufficiently unfortunate in being overburdened with names, a comparison with authentic specimens showing it to be the same as *Bovista pila* B. & C., and *B. tabacina*, Sacc. It now becomes *Scleroderma Oregonense* and *Lanopila? tabacina*! The specific name *pila* being the one first given must take precedence, and unless the genus *Bovista* is to be abandoned I see no good reason why the generic name given by B. &. C. should not also remain. The species in question is closely allied to *Bovista nigrescens*, Pers. So closely in fact that, regarding only its external characters it could not safely be separated from that species. Its internal characters, however, are slightly different.

The true *B. nigrescens* (See English and Italian spec.) differs in its rather larger (5μ) spores, which are also often very slightly muriculate-roughened and have a hyaline pedicel about equal in length to the diameter of the spore, while in *B. pila* the spores are generally a little paler, not distinctly pedicellate and quite smooth. In both the capillitium is about the same, forming loose balls (2^{mm} diam.) closely packed and filling the entire peridium with a firm elastic purplish-brown mass. When examined microscopically this capillitium is seen to be made up of numerous small knots or ganglia consisting of intricately entangled

masses work of coarse, purplish-brown, branching threads 12 to 15μ. thick, which send out on all sides free, sub-dichotomously branched, sub-undulate arms tapering gradually nearly to a point and more or less distinctly granular-roughened or occasionally sub-tuberculose. *Mycenastrum corium*, Desv., of which, as shown by a comparison with authentic specimens *M. spinulosum*, Pk., is a synonym, has the capillitium of the same type only spinulose. This species is really only a *Bovista* with spinulose capillitium, and if the genus *Mycenastrum* is to be abandoned must fall into *Bovista* and not into *Scleroderma*, which differs in its thick, leathery peridium and different capillitium. If *Bovista pila* is to be placed in *Scleroderma* it is difficult to see why *B. nigrescens* and *B. plumbea* should not go there also. Nor is *Mycenastrum Ohiense*, E. & M., any more at home here, though it is not so easy to say just where it does properly belong, having, as it does, the sterile base of *Lycoperdon* with the capillitium of *Bovista*. I would leave *Bovista pila*, B. & C., where it is and make *Mycenastrum* a subgenus of *Bovista*, or if retained as a genus (which is perhaps preferable) restrict it to species with a spiny capillitium.

On page 53 of the volume cited we find another species to which several synonyms must be attached. (See S. Schulzer in Hedwigia, 1883, p. 43.) *Secotium Warnei*, Pk., *Columnaria*, Schulz., and *Secotium Thunii*. Schulz. are the same as *Secotium acuminatum* (Mont.) Tul.

This perhaps is not to be considered as a fault in the editor of the Sylloge, as this work aims only to give published descriptions; but without explanation one would suppose three distinct species where there is really but one.

Lycoperdon lepidophorum, E. & E., placed by Dr. De Toni in *Bovista*, we consider a good *Lycoperdon*, though not mentioned by Mr. Massee in his monograph of that genus. The deciduous scales correspond to the deciduous spines in some other species of *Lycoperdon* and are not to be considered as an outer peridium. The true peridium which is exposed when the outer scaly covering falls away is very thin and fragile and soon disappears.

SOME NEW SPECIES OF HYMENOMYCETOUS FUNGI.

By J. B. Ellis and Benj. M. Everhart.

Inocybe pallidipes, E. & E. (N. A. F. 2102.) On the ground, under filbert trees, September and October, 1887 and 1888.

Pileus conic-campanulate, about 1^{cm} high, finally expanding and umbonate, 2 to 3^{cm} across, light brown, fibrose-squamose, margin subrimose, disk innate-squamose or subrimose squamose. Lamellæ broadly attached with a strong decurrent tooth, ascending at first, then ventricose, scarcely crowded, rather broad (3^{mm}), pale, becoming light watery cin-

namon or clay color, margins lighter, and under the microscope fringed with cylindrical, obtuse, hair-like bodies (abortive cystidia?) Stem $2\frac{1}{4}$–5^{cm} high, 2–4^{mm} thick, subattenuated and farinose above, white, solid, loosely fibrillose below, sub-bulbous and white tomentose at base, faintly annular marked above the middle when young, but this is hardly discernible in the mature plant. Spores brown, inequilaterally elliptical, 7–8 by 4–5μ. Basidia clavate-cylindrical, about 22 by 8μ, with sporophores about $3\frac{1}{2}\mu$ long. Cystidia ventricose-fusoid or flask-shaped, 40–45 by 14–16μ. The disk of the pileus is carnose, and in wet weather rimose-squamose.

Well marked by its conic-campanulate pileus and *white stem*, which remains white till the plant withers.

This and the other species of *Inocybe* here described were all found at Newfield, N. J.

INOCYBE MURINO-LILACINUS, E. & E. (N. A. F. 1905.) On bare ground under chestnut and filbert trees, September to October.

Pileus convex, 2–4^{cm} diameter, umbonate-discoid, silky-fibrillose, at length becoming squamulose around the margin, umbonate-discoid in the center, mouse-color, with a tinge of lilac when fresh and young. Stem 2 2–4^{cm} high, 2–4^{mm} thick, fistulose and soon hollow. Spores narrow-elliptical, with an oblique apiculus, rust-color, 7–9 by 4–5μ. Basidia 22–25 by 7μ, clavate-cylindrical.

The broad, prominent disk of the pileus either has a small umbo in the center or a slight depression and is generally surrounded (about half-way to the margin) with a distinct ridge or zone. The margin also projects slightly and is a little lighter colored, and, under the lens, subfimbriate.

INOCYBE CICATRICATUS, E. & E. (N. A. F., 1901.) In gravelly sand near filbert trees, August–October.

Pileus broadly and obtusely conical or conic-campanulate, expanding to convex, 2–$2\frac{1}{2}^{cm}$ across, densely gray fibrillose-rimose, except the smooth (livid when moist) disk. Flesh white, compact in the disk, almost disappearing towards the margin, which is a mere membrane. Lamellæ, ascending, narrowly attached, with a slight decurrent tooth, becoming sub-sinuate, dirty white at first, becoming dirty cinnamon brown, 3–4^{mm} wide. Stem stout, short ($1\frac{1}{2}$–3^{cm}), 2–4^{mm} thick, sub-bulbous at base, solid, nearly white, and covered with a short tomentose-pubescent coat at first, finally darker and smoother and very often eaten out by worms so as to appear hollow and then easily splitting. Spores very irregular in shape, mostly longer than broad, 7–9 by 5–6μ. Cystidia broad-fusoid, 50–55 by 12–15μ.

This comes near *A. umbonionotus*, Pk., in the 38th report, but the pileus is not umbonate nor are the spores nodulose, but simply angular (subquadrate), as represented in his *A. maritimoides*, which again is said to be "densely squamulose with small, erect or squamose-fibrillose scales."

The disk has something the appearance of a scar; hence the specific name.

INOCYBE ECHINOCARPUS, E. & E. (N. A. F., 1904.) On the ground in an old abandoned road among oak bushes, September–October.

Pileus conic-convex, not readily expanding, $1\frac{1}{2}$–2^{cm} across, pilose-squamose, disk broken up into stouter scales similar to those of *Hydnum imbricatum*, color tawny yellow. Lamellæ subventricose, rounded behind and narrowly attached or nearly free, scarcely crowded, dirty-pallid, becoming clouded by the ferruginous spores, margins whitish and nearly entire. Stem $2\frac{1}{2}^{cm}$ long, 2–3^{mm} thick, solid, of fibrous texture, tough (bends short without breaking), farinose-floccose above, sub-attenuated and slightly silky-fibrillose below, a little darker than the pileus. Spores *echinate* (not simply angular or tuberculose), but thickly beset with short spines, irregularly globose or a little elongated, 8–11μ, diameter on subventricose basidia about 30 by 10μ, with stout, slightly spreading sporophores 4–5μ long.

This is a well-marked species, easily recognized by its echinate spores, broad basidia, and coarsely squamulose disk. There is no sterile projecting margin to the pileus, the ventricose gills coming out full to the margin. The measurement of the spores includes the length of the projecting spines and is mostly 8–10μ, exceptionally 11μ. This differs from *A. stellatosporus*, Pk., in its larger *echinate* spores and stem not scaly.

INOCYBE SUBDECURRENS, E. & E. (N. A. F., 1906). On the ground under the overhanging branches of Norway spruce, September–November.

Densely gregarious. Pileus 4–5^{cm} across, convex, expanding to plane, with disk depressed and either umbonate or not, but oftener without any umbo, surface densely and evenly appressed-pilose, color yellow-drab, flesh thin. Lamellæ moderately close, adnate-decurrent, pale dirty cinnamon, not changing much in color with age, about 3^{mm} wide, margins serrulate. In the mature plant the lamellæ are very slightly ventricose, but never depressed around the stem. Stem mostly straight, sub-equal, *hollow*, fibrillose-squamose above, covered with loose white silky fibres below and white tomentose at base, 3–4^{cm} high, $\frac{1}{2}$–$\frac{3}{4}^{cm}$ thick, moderately tough. Spores elliptical, rounded at both ends, without any distinct apiculus, ferruginous cinnamon, 8–10 by 4–5μ on basidia, about 25 by 7–8μ. The stem is not simply fistulose, but in all mature specimens *hollow*.

This has been found in the same place in great abundance now for three years in succession.

INOCYBE TOMENTOSA, E. & E. (N. A. F., 2101). On the ground in grass, around and partly under the overhanging branches of Norway Spruces, at a short distance from the preceding species, but not mixed with it. July–September, 1888.

Gregarious and sub-cespitose. Pileus plano-convex, depressed in the center and generally with a small umbo, 2–4^{cm} across, margin at first

incurved and connected with the stem by a loose, dirty white, cottony web, surface *appressed strigose-tomentose*, light-drab color becoming yellowish. Stem 2–3^{cm} high, 2–3^{mm} thick, solid or at least with only a slight cavity above, indistinctly annular-marked above the middle, surface loosely fibrose-cottony, white tomentose at base. Lamellæ attached with a slight decurrent tooth, finally slightly depressed around the stem, pale at first, then dirty cinnamon, 3–4^{mm} wide, hardly crowded, margins subserrulate. Spores elliptical, slightly inequilateral, 6–8 by 4μ, dark rust color, on clavate-cylindrical basidia about 27 by 7μ with erect sporophores 3–4μ long. The surface of the pileus can not be called striate, though the loosely matted hairs all radiate from the center. Smell not farinaceous, rather unpleasant.

I. subdecurrens is larger, with a *hollow* stem, and has the gills more crowded, nor is the margin incurved and tomentose, and it is also of a rather darker shade and has the margin of the gills more strongly serrate.

In *I. tomentosa* the margin remains incurved till the plant is nearly full grown. In *I. subdecurrens* the margin is never incurved even when young, nor is there any annular mark on the stem though the fibrous veil is at first distinct. There does not seem to be any doubt that the two species are distinct, though their general appearance is much the same.

AGARICUS (HYPHOLOMA) OLIVÆSPORUS, E. & E. (N. A. F. 2009.) Among moss in swamps. Newfield, N. J., July, 1888.

Pileus 1½–2^{cm} across, convex, subumbonate, dark brick color when moist, lighter when dry, covered with a dense furfuraceous or mealy coat which soon disappears. Lamellæ free, rounded behind, nearly plane, unequal, chestnut-brown (at first purplish-violet or purplish-brown), becoming lighter when dry and more or less tinged with brick-red. Stem slender, 3–4^{cm} high, 1½–2^{mm} thick, more or less curved or bent, about the same color as the pileus, and like it furfuraceous at first, of fibrous texture, fistulose, the cavity loosely filled, rather brittle. Spores when fresh olive-brown, the green shade very distinct, elliptical, 3½–4 by 2μ. Basidia clavate, with the apex rounded, 15–20 by 6μ. Spores becoming umber-brown in drying. There is no sign of any annulus on the stem.

The pileus when young is sometimes brick color, but soon becomes grayish-buff, except the umbonate disk, which retains more or less of the reddish tint. The loose mealy covering of the pileus is very distinct and does not entirely disappear in the mature plant. The margin of the pileus is not involute, hardly incurved, and is at first connected with the stipe by a loose webby veil, which remains hanging to the margin as the pileus expands. The plant is sometimes sub-cespitose and often grows from pieces of wood buried in the soil.

Resembles *A. microsporus*, Ell., in general appearance, but that has *white spores* and the stem strigose below and rooting.

MUCRONOPORUS E. & E.

A NEW GENUS OF POPOLYPOREÆ.

In examining some specimens of *Polyporus* in our herbarium we find several species having the inner surface of the pores studded with reddish-brown spines exactly as in the hymenium of *Hymenochæte*. The only described species having this character, so far as we know, is *Polystictus balansæ*, Speg., of which Saccardo (in Syll.) remarks that it might well be the type of a new genus ("facile novum genus"). And in fact it is just as reasonable to separate the spiny-pores species under a new generic name as to separate *Hymenochæte* from *Stereum*. We therefore here propose to separate these species, which are mostly of the genus *Polystictus*, under the generic name of *Mucronoporus* (Mucro and porus.)

MUCRONOPORUS CIRCINATUS. (Fr.). Fine specimens of this species were found some years ago at Newfield, N. J., among the decaying roots of an old cedar stump. Spines abundant, more or less curved, 60–75 by 8–10μ.

MUCRONOPORUS DUALIS. (Pk.) (specimen from Peck.) has the same hooked spines as the preceding, and is probably a form of that species.

MUCRONOPORUS TOMENTOSUS. (Fr.). Specimens collected by Dr. J. Macoun on Prince Edward Island. Spines very distinct, ovate lanceolate at first, finally more slender 35–70 by 12–20μ.

On account of the spiny hymenium we at first supposed this to be a new species, but authentic specimens of *Pol. tomentosus* from Finland (ex Herb. Karsten) have the hymenium of the same character, and there can be no doubt that the Prince Edward Island specimens are that species. A drawing has been made of one of these specimens, and we add a brief description.

Centrally stipitate. Pileus orbicular, 6–12^{cm} across, thin, strongly depressed in the center, light dirty yellow, innate tomentose, mostly zoneless, but sometimes indistinctly zonate, margin paler. Flesh of pileus light yellow, of fibrous texture about 2^{mm} thick, subcoriaceous. Pores of medium size, about 2^{mm} deep, round or sub-angular, some of them compound, *i. e.*, divided below by partial dissepiments, margins thin, whitish, and sub-lacerate, umber color within. Stipe 1–3 by $\frac{1}{2}$–1^{cm} spongy, cinnamon color, minutely tomentose. The general appearance is that of *P. perennis*, but the pileus is of a brighter yellow and more distinctly tomentose, and the inner surface of the pores is studded with reddish brown ovate conical bodies 35–75 by 12–30μ, apparently of the same character as the bristles in *Hymenochæte*, only stouter. Plate VIII, figs. 1 and 2, show the upper and lower surface of the pileus. Fig. 3, section of pores, showing the projecting points or spines. Fig. 4, one of these spines magnified. Fig. 5, spine with a bifid tip.

MUCRONOPORUS GILVUS. (SCHW.). In all the specimens of this species the spines are present but not abundant. They project 15–20μ and are about 4–5μ thick at the base.

Mucronoporus isidioides, (Berk.). The specimens of this species in de Thümen's Mycotheca 1105, from South Africa, as well as those from Ohio (ex herb. Berk.), have spines of the same appearance as in the specimens of *P. gilvus*, and this is another indication that this so-called species is only a form of *P. gilvus*.

Mucronoporus setiporus, (Berk.). (Specimens from Ceylon, com. Cooke.)

Spines 25–30 by 4μ.

Mucronoporus licnoides, (Mont.). (Specimens from Brazil, com. Cooke.)

Spines abundant, rather short, 15–20μ.

Mucronoporus cichoriaceus, (Berk.). (From Australia, com. Cooke.)

Spines quite abundant, projecting 25–35μ long, and about 5μ thick at the base.

Mucronoporus tabacinus, (Mont.). (From New Zealand, com. Cooke.)

Spines more abundant than in the specimens collected by Dr. Martin in Florida and distributed in N. A. F. 1705.

Mucronoporus spongia, (Fr.). (Specimen from Cooke.)

Spines 20–25 by 6–8μ, curved like the spines on a rose bush.

Mucronoporus crocatus, (Fr.). (Specimens in Rav. F. Am. 707 and 708.)

Spines 25–30 by 4–5μ.

Mucronoporus balansæ, (Speg.).

Fungi Guaranitici Pugill. I. No. 42. Spines 20–25 by 5–6μ.

In the measurement of the spines we have given the length of the projecting part. The base of the spines penetrates more or less deeply into the hymenial layer of the pores, and if this is included the length will be somewhat greater.

TRIBLIDIUM RUFULUM (SPRENZEL).

By J. B. Ellis.

This appears to be a variable species. The specimens in Rav. Fungi Car. Exsicc. II, No. 47, have the sporidia oblong, slightly curved, nearly opaque, 3-septate, 24–30 by 10–12μ, very slightly or not at all constricted at the septa. Specimens found by Mr. Langlois (No. 130) on dead fig tree in Plaquemines Parish, La., agree with Ravenel's Carolina specimens, unless in having the sporidia a little more constricted. In the specimens from both these localities the hymenium is of a deep *brick-red* color and the lips are slightly transversely striate. Specimens collected at Ocean Springs, Miss., in February, 1887, by Mr. F. S. Earle (No. 202), agree with the Carolina and Louisiana specimens in all respects except in having the sporidia only 1-septate and a little smaller

(18–22 by 8–10μ). We have designated this as var. *simplex*, E. & E. Specimens found by Col. W. W. Calkins near Jacksonville, Fla., January, 1889, have the 3-septate (24–30 by 10–12μ) sporidia of the Carolina and Louisiana specimens, but the hymenium is *slate* color, the perithecia cespitose (they are scattered in all the others), and the lips very distinctly striate. We have called this var. *fuscum*, E. & E.

BRIEF NOTES ON A FEW COMMON FUNGI OF MONTANA.

By W. F. Anderson.

Claviceps purpurea, said to be comparatively rare in many Eastern States, is found everywhere in the Territory. I have found it on four species of *Elymus*, on three species of *Poa*, on six species of *Agropyrum* as well as on *Kœleria cristata*, *Phalaris arundinacea*, and several other grasses. The little rye grown is not materially injured by the *Claviceps*. I have collected this fungus at 8,000 feet altitude; it is as common at that height as at 3,000 feet—the general average of Montana's plains above sea level.

Some years the loss to stock-men from the abortions of cows and mares is heavy. Many claim that losses from this cause are greater in seasons when an unusual abundance of ergot is developed on the grasses; but there are others who scout this idea. However, whether the eating of ergot in considerable quantity by stock has an irritating influence on the internal genitals or no, it is certain that the general health of the animals is impaired thereby.

Ustilago caricis is remarkably plentiful, pretty regularly every other year. Whether it is a baneful fungus to the health of stock I am not prepared to say. It is at any rate seriously injurious to three small but important forage plants, viz: *Carex filifolia*, *Carex stenophylla*, and *Carex Douglasii*. These sedges, especially the first, comprise a considerable proportion of the "grass" on the plains, and are eagerly eaten by stock. In April they are in flower and by the 1st of May their fruit is more or less fully developed. Diseased spikes are very conspicuous in the immature stage of the fungus by the round lead-colored balls attached to them. Later this lead-colored coat breaks, and the intensely black spores are seen to cover the balls. Stock avoid plants in this condition.

Ustilago segetum as yet is not seriously injurious to cultivated cereals. It is rather common, however, on the weed *Hordeum jubatum*.

Ustilago minima is common on *Stipa comata*. It destroys the panicle almost entirely. In autumn the bare blackened rachis breaks out of the sheath and curves outward and downward, almost touching the ground.

Another *Ustilago* which bids fair to do considerable damage to *Muhlenbergia* as soon as that grass is cultivated as a regular crop is the new

Ustilago Montaniensis Ellis & Holway, on *Muhlenbergia glomerata* var. *setiformis*, first discovered by the writer December 12, 1887. This appears to be one of the most destructive species of *Ustilago* we have. The host plant begins to "head out" when it is 3 inches high. These early panicles are lateral, and smaller than the final terminal panicle, which, under favorable conditions, is developed by the time the plant is 24 or 30 inches high. Culms affected by the fungus are generally stunted and thickened, becoming harsh and knotty. Their panicles are usually aborted from first to last. Sometimes only the lower or middle spikelets in the dense spikes are infected, the rest being perfect and producing seed. In the case of the small lateral panicles, which are mostly smutted entirely, the panicles do not grow out of the sheaths, but are inclosed by the united and membranous bases of the sheathing leaves. As the fungus develops this usually cylindrical or oblong sac enlarges and gradually loses its leaf-character, except where its two parts extend above and beyond the inclosed panicle. The membrane surrounding the smut has by this time become a leaden-gray color, and exceedingly thin and chartaceous. Where only more or less isolated small spikes and spikelets of a panicle are affected, the surrounding membrane is formed by the uniting of the glumes, which are free and maintain their true character only at their tips.

Three times out of five if the fungus is present it affects all the panicles. When the very first one appears in an infected plant it will be found full of smut, and each succeeding panicle as it is developed will be found to be in a similar condition, so that it is evident the fungus develops with the host. The host is a perennial, and so far as I have been able to discover by examining old and new culms, representing four years' growth, the plant once attacked is affected each succeeding year until its death. As *Muhlenbergia* is a valuable grass and will soon be common in cultivation, this fungus ought to receive careful attention.

Erysiphe graminis is a common pest in some sections, notably in southern Montana, west of the main divide of the Rocky Mountains. It affects chiefly the *Poas* and is especially damaging to *Poa tenuifolia*, one of our most valued forage grasses. The asci of the fungus contain ripe spores in November.

Puccinia rubigo-vera is common everywhere. I have collected it on fourteen species of native grasses. It is most damaging to *Elymus condensatus*. Wheat and oats do not suffer from it as yet.

Puccinia tanaceti occurs on many hosts. The cultivated Sunflower is sometimes ruined by this fungus. The common Sage-brush (*Artemisia tridentata*) is frequently attacked so overwhelmingly by *Puccinia tanaceti* that its flowers dry up and its leaves fall off. The fungus attacks the younger stems and shoots, blackening them also. I have found it on five species of *Artemisia*, viz: *A. tridentata*, *A. cana*, *A. Ludoviciana*, *A. frigida*, and *A. dracunculoides*. On *A. dracunculoides* and *A. Ludoviciana* I have found one of the numerous *Æcidium com-*

positarum forms occurring with the uredo of *Puccinia tanaceti*, closely followed by the teleutospores. The same *Æcidium* occurs on all five, and is invariably followed, if not accompanied, by the uredo and teleutospores of this fungus.

PHRAGMIDIUM SUBCORTICIUM occurs, sometimes to an alarming extent, on *Rosa Arkansana*, *Rosa blanda* (?), and *Rosa Sayi*. No doubt it would do serious damage to cultivated roses in certain localities. At Helena in 1887 I found several cultivated varieties more or less affected by the *æcidium* of this fungus. On the wild roses the uredo and teleutospores do serious injury, some years destroying the leaves.

MELAMPSORA SALICIS is found on nearly all our Willows. I have found it abundantly on *Salix longifolia*, *S. cordata*, *S. amygdaloides*, *S. rostrata*, *S. flavescens*, and *S. glauca*. It appears to be most injurious to *Salix cordata* and *Salix flavescens*. Sometimes in the early fall great clouds of the red uredospores are blown from the trees, sprinkling the vegetation for some distance around. Last year this *Melampsora* was unusually prevalent and vigorous in its attacks. I found it both sides of the main divide of the Rocky Mountains, from the southern border of the Territory and the source of Clarke's Fork of the Columbia River and the source of the Missouri River, thence northeastward to within fifty miles of the Canadian line. Good sized trees in some localities were almost entirely defoliated. On the banks of the Upper Missouri, in one locality, were found in September several hundred acres of seedlings of *Salix amygdaloides* and *Salix cordata*, then from 3 to 6 inches high and as close as grass, which were probably permanently ruined by the uredo of *Melampsora salicis*. The leaves, especially the lower ones, had all fallen from the effect of the parasite and were decaying. The upper leaves were almost devoid of chlorophyll and evidently perishing.

MELAMPSORA POPULINA, like the last, was very abundant last year and did considerable damage to *Populus tremuloides* and *P. angustifolia*. I also found it on *P. monilifera*, *P. balsamifera*, and *P. angulata* more sparingly.

MELAMPSORA LINI some seasons is ruinous to *Linum rigidum*, and also sharply attacks *Linum Lewisii* (commonly called *L. perenne* by western collectors). *Linum Lewisii* is rather similar to the cultivated flax, and if the latter were introduced it would doubtless suffer more or less from this fungus.

SPOTTING OF PEACHES.

By ERWIN F. SMITH.

A recent paper on this subject by Dr. J. C. Arthur (Bull. Agr. Exp. Sta., Indiana, No. 19, 1889) leads to the following remarks:

Cladosporium carpophilum, v. Thümen is undoubtedly the conidial stage of some well-known ascomycetous fungus. It occurs on the leaves

as well as the fruit, and I think also on the branches. It is by no means confined to Indiana, or rare in any peach district in the United States. It is common along the Atlantic, in the region of the Great Lakes, in the Lower Mississippi Valley, and in California. In Maryland and Delaware it has been known for many years, and is so abundant that its presence is regarded as a matter of course. The choice early peaches and the middle varieties are little subject to it, but Smocks and nearly all late and inferior sorts are more or less spotted. So constant is this spotting that many peach-growers have come to consider it as *characteristic* of certain varieties and have no idea that it is abnormal.

It injures the appearance of the fruit somewhat, and when very abundant the flavor also, unless I have been much deceived. Growers do not generally regard it as a serious evil, or indeed as a matter of any consequence. The loss in late sorts with firm flesh is nevertheless sometimes very considerable. So far as my own observation goes this results principally from cracking and rot, in much the same way as in apples and pears when badly attacked by *Fusicladium*. The half-grown peach forms a protective layer of cork beneath the most thickly spotted surface. This cork layer is incapable of further growth and is ruptured in deep irregular fissures when the peach rapidly enlarges during the last few days of its growth. The spores of *Monilia fructigena* Pers. fall upon this exposed surface and rot begins immediately. The cracking appears to be worse in rainy weather, which is also the most favorable condition for the rapid development of the rot. In September, 1888, in the great peach region of Maryland and Delaware (the north part of the peninsula) fully one-half of the Smock peaches, aggregating many thousand baskets, were lost by rot during a rainy week. Cracking of the fruit often preceded this rot and was due in part to *Cladosporium*. Nevertheless the loss would have been inconsiderable but for the presence of this other much worse parasite—the rot fungus.

In 1886 and 1887, two very rainy seasons *Cladosporium carpophilum* was abundant in Maryland and Delaware, and I am therefore inclined to think that dry seasons are not specially favorable to its growth.

EXPERIMENTS IN THE TREATMENT OF GOOSEBERRY MILDEW AND APPLE SCAB.

Prof. E. S. Goff, of the New York Experiment Station, has kindly furnished us with the results of his experiments in the treatment of these diseases in 1888, which we give in full below:

POTASSIUM SULPHIDE FOR THE GOOSEBERRY MILDEW.

At the suggestion of Dr. J. C. Arthur,* formerly botanist to the

* For results secured with this substance by Dr. Arthur in 1887, see Report New York Agricultural Experiment Station, 1887, pp. 248-252.

station, a series of trials was made with potassium sulphide (liver of sulphur) as a preventive of injury from the disease of the gooseberry plant commonly known as "mildew," and due to a fungus parasite known to science as *Sphærotheca mors-uvæ* B. & C. The substance was applied in solution at the rate of one-half and one-fourth ounce to the gallon, respectively, commencing May 3, or as soon as the leaves had begun to expand, and the application was repeated after every hard rain until June 24, nine sprayings having been made in all. The experiment was made upon a row of the Industry gooseberry containing five plants, and upon a plat of seedlings numbering 282 plants.

Toward midsummer the effect of the spraying became distinctly visible in the deeper green foliage and more rapid growth of the treated plants. On June 23 the two plants of the Industry gooseberry that received the sprayings were noted as being entirely free from mildew, with the exception of a trace of it observed on a single fruit, while the three not treated were quite badly affected. The fungus appeared as a downy coating near the ends of the new shoots, and also upon the berries. The new growth, as well as the crop of fruit, was very perceptibly greater on the treated plants. At this time the bed of seedlings had not been perceptibly attacked by the fungus.

On July 16, the seedling plants were found to be considerably affected, and an examination showed that in the row treated with the sulphide at the rate of half an ounce to the gallon, only one plant exhibited signs of mildew out of a total of 60—about 1.7 per cent; in the row treated at the rate of one-fourth ounce to the gallon 3 plants were affected out of 43—about 7 per cent.; while in 133 plants not treated, 15 were affected, or about 11.3 per cent.

As these plants were all seedlings from native varieties and are not all subject to mildew, these figures are only an indication of the effects of the treatment and not a proof, for I do not know how many plants in the treated rows would have been affected had the applications not been made. There could be no question, however, as to the benefits resulting from the treatment. As far as the plantation could be seen the sprayed rows were conspicuous for the richer green of their foliage; and the row receiving the stronger solution showed somewhat greater vigor than the other. A part of this benefit, however, probably resulted from the influence of the sulphide in destroying or repelling the currant worm, as the treated plants were noticeably less injured by this insect than the others. A part also may have resulted from the fertilizing effect of the potash applied.

In the latter part of summer, after the spraying had been discontinued, the mildew increased on the treated plants, showing clearly that the applications were beneficial, and also that they must be continued throughout the growing season to confer their greatest benefit.

SODA HYPOSULPHITE CONTRASTED WITH POTASSIUM SULPHIDE AND CALCIUM SULPHIDE FOR THE APPLE SCAB.

In former reports are given the results of experiments with soda hyposulphite for the apple scab, *Fusicladium dendriticum*, Fckl. From these it appears conclusively that this substance as used acted beneficially, but that it was not a complete remedy for this disease. It is very desirable that some substance be found that will prove more effectual in destroying this fungus without causing greater harm to the foliage. Two other compounds of sulphur, viz, potassium sulphide and calcium sulphide, were therefore tested the past season. The first trial was made with the potassium sulphide in solution, at the rate of half an ounce to the gallon, upon the crab-apple tree treated for three seasons preceding with soda hyposulphite, as described in the experiments cited.

The spraying, which was done with the so-called Little Gem force-pump, fitted with a "Climax" nozzle, was made upon the west half of the tree only, and was commenced May 10, just as the leaves were expanding, and repeated after every hard rain until July 24, eight applications having been made in all.

The tree blossomed alike, apparently, on both the sprayed and unsprayed portions, but the crop of fruit matured was much larger on the sprayed part, and, as the following figures will show, was of much better quality.

On September 12 a quantity of fruit was picked from the sprayed and from the unsprayed parts of the tree, and each lot assorted into three classes, in order to determine their relative injury from the disease. In the first quality were put only fruits nearly or quite free from scab; in the second those that were considerably scabby, but not so much as to distort their form or prevent them from acquiring their normal size, and in the third those which were distorted in form or diminished in size by the growth of the fungus.* The results secured as follows:

	Number of fruits examined.	Per cent. in first quality.	Per cent. in second quality.	Per cent. in third quality.
Sprayed part	1,560	75.9	22.6	1.5
Unsprayed part	627	46.9	45.3	7.8

More than 627 fruits did not mature on the unsprayed part of the tree. On the sprayed part, however, many more might have been gath-

* This classification is necessarily somewhat arbitrary, but, as the assorting was done with care, it is believed that the figures represent the true proportions of the amount of injury wrought by the scab. Almost all the fruits were somewhat scabby in the cavity about the stem, but if not affected elsewhere, this did not exclude them from the first quality.

ered. If we ascribe the larger crop on the sprayed part to the influence of the application, it is evident that the figures express but a small part of the benefit resulting from the treatment. Aside from the difference in crop, the fruits on the unsprayed portion were inferior in size to those on the other part.

A comparison of the results secured the past season with potassium sulphide with those secured on the same tree in 1885 and 1887 with soda hyposulphite would indicate that the former proved the more effectual. Such a comparison, however, may not be just.

In a second trial, ten trees of the Fall Pippin apple were treated as above described, with solutions of three compounds of sulphur, viz: Soda hyposulphite, at the rate of half an ounce to 10 gallons; potassium sulphide, half an ounce to the gallon; and calcium sulphide in a saturated solution, the spraying in every case being made on the same day and in the same manner. The trees were divided into three series, the second, fifth, and ninth forming the second, and the third, sixth, and tenth the third series. The first sprayings were given June 5, by which time the leaves were well expanded. Other sprayings were made June 16, June 27, and July 2, each of which shortly succeeded a hard rain.

On September 21 the fruits on the sprayed and unsprayed portions of each of the ten trees were picked, with the exception of a belt about 3 feet wide across the center of the trees where the sprayed and unsprayed parts were supposed to meet. The apples were then assorted into three qualities, as described in the case of the crab apple tree, with the following results:

	Number of fruits examined.	Per cent. in first quality.	Per cent. in second quality.	Per cent. in third quality.
First series—Soda hyposulphite:				
Sprayed part	495	56.56	27.91	16.43
Unsprayed part	397	46.85	27.96	25.19
Per cent. in favor of sprayed part		9.71		8.76
Second series—Potassium sulphide:				
Sprayed part	960	31.35	40.11	28.54
Unsprayed part	247	22.67	36.03	41.30
Per cent. in favor of sprayed part		8.68		12.76
Third series—Calcium sulphide:				
Sprayed part	315	28.26	40.95	30.79
Unsprayed part	129	37.21	33.33	29.46
Per cent. in favor of unsprayed part		8.95		.67

From this trial it does not appear that the potassium sulphide was decidedly more effectual than the soda hyposulphite, although as applied it contained about fifteen times as much sulphur. The soda hyposulphite injured the foliage somewhat, and evidently could not be safely used in a stronger solution.

The calcium sulphide apparently did no good whatever. This substance is only very sparingly soluble in cold water, which may account

for its inaction. The fact that the sprayed part, when treated with this substance, showed so much greater percentage of injury than the unsprayed throws a possible doubt over the whole trial, for we can not suppose that this compound of sulphur could have favored the growth of the fungus.

The results of these tests appear to warrant the following conclusions:

First. That soda hyposulphite and potassium sulphide, as applied, proved beneficial in preventing injury from the fungus. This conclusion is strengthened by the results secured in previous experiments already cited.

Second. The tests do not prove that the greater amount of sulphur added in the potassium sulphide as compared with the soda hyposulphite rendered this substance the more effectual, though there are indications in this direction.

Third. That calcium sulphide is of little or no value for the purpose used.

Fourth. That while further experiments are needed to furnish data from which we may compute the actual benefits conferred by the treatments, the indications are that the good accomplished was sufficient to warrant the slight cost of the materials in the case of orchardists who spray their trees for the codling moth.

NOTES.

BY B. T. GALLOWAY.

SULPHURET OF POTASSIUM FOR BITTER ROT OF THE APPLE.

Judging from the reports received bitter-rot of apples (*Glœosporium fructigenum*) is on the increase. Last year (1888) Mr. J. W. Beach, of Batavia, Ark., made some experiments with the view of finding a remedy for this disease which are not without interest. We wrote Mr. Beach early in March, 1888, requesting him to spray the fruit five or six times during the season with a solution of sulphuret of potassium, one-half an ounce of the potassium to the gallon of water. In accordance with our instructions the first application was made when the apples were about one inch in diameter, and the Lewis Combination Force Pump was used for the purpose. The second application was made three weeks later, and was followed by a third in about a month. Up to the time of the third application very little rot had appeared on the sprayed apples, while those not sprayed rotted badly. Unfortunately at this time the supply of the fungicide became exhausted and nearly two months elapsed before enough was obtained to make the fourth application. During this interval much of the sprayed fruit which had hitherto remained healthy fell a prey to the disease, and, in spite of all treatment, this continued until the fruit was harvested. Mr. Beach, however, has full confidence in the remedy and says that during the

coming season "every precaution will be taken to apply it in *advance of the fungus*."

This last statement is the key to success in the treatment of all fungous parasites. The treatments must be made before infection has taken place.

BORDEAUX MIXTURE FOR THE PLUM LEAF-BLIGHT.

In many parts of the South and West peach and plum trees suffer from the attacks of a parasitic fungus (*Puccinia pruni-spinosa*) belonging to the rust family. This fungus attacks the leaves, causing them to fall long before the proper season. During the summer and autumn of 1888 Prof. T. L. Brunk, at our suggestion, conducted a series of experiments at the Texas Agricultural College with the view of finding a remedy for this pest. Professor Brunk writes as follows concerning the results of his experiments:

I am greatly encouraged by our experiments with the Bordeaux mixture sprayed upon two rows of trees August 21 last. Two rows which alternated with three others that were carefully and thoroughly pruned last winter were selected for the spraying. On October 5 the plants were examined and it was found that those not treated had lost nearly all of their foliage, while those sprayed had lost only a very small per cent.

Professor Brunk concludes as follows:

At this writing (October 30) the difference in the treated and untreated trees is very marked. Those that were sprayed have yet about two-fifths of their leaves, while the alternating check-rows are nearly leafless. We intend to begin in the spring next year, and I believe that if the trees are sprayed about three times during the growing season—the first when the fruit is setting, the second about a month later, and the third in August, or after the fruit is picked—that the fungus will cause little injury.

A TOMATO DISEASE.

Of late years Mr. Marcius Wilson, of Vineland, N. J., has had considerable trouble with a fungus which attacks his tomatoes, especially those grown under glass. It appears on the leaves and young shoots at any time during the winter, and often kills them outright or greatly injures their vitality. From specimens communicated by Mr. Wilson it was learned that the disease was caused by *Cladosporium fulvum*, a fungus which has occasioned considerable injury in England.

According to Col. A. W. Pearson, Mr. Wilson has succeeded this year in completely holding this fungus in check by the use of the Bordeaux mixture, containing 6 pounds of copper and 4 pounds of lime to 22 gallons of water. The first application was made in December, while the plants were yet apparently healthy. For applying the remedy the Eureka Sprayer was used, and it answered the purpose "admirably."

REVIEWS OF RECENT LITERATURE.

WORONIN, Dr. M. *Ueber die Sclerotienkrankheit der Vaccinen-Beeren.* Entwickelungsgeschichte der diese Krankheit verursachenden Sclerotinien, mit 10 Tafeln. Mémoires de l'Académie impériale des Sciences de St. Pétersbourg, VII. Sér., Tome XXXVI, No. 6., Prix: 6 m.

The *Sclerotium diseases of Vaccinium berries* is the title of a new German work by Dr. M. Woronin, which forms one of the memoirs of the Royal Academy of Sciences of St. Petersburg.

Four species of *Sclerotinia*, each attacking a different species of Vaccinium are described and illstrated. The species and hosts are (1) *Sclerotinia vaccinii*, Wor. on *V. Vitis Idæa;* (2) *S. oxycocci*, Wor. on *V. oxycoccus;* (3) *S. baccarum*, Schr. on *V. myrtillus;* and (4) *S. megalospora*, Wor. on *V. uliginosum.*

The first named species is described in detail, and the following abstract consists mainly of the author's own summary.

Sclerotium vaccinii is a true parasite, which, however, leaves its host when the Sclerotium is mature, in order to develop itself farther at the expense of the reserve material which it has already appropriated.

The gonidial stage appears in the spring upon leaves and stems of the new shoots of the Cowberry, in the form of a dense, powdery, mold-like coating which emits a strong, pleasant, almond odor. On the stem the fungus usually appears near the end and only on one side, causing the branch to bend so that the fungus comes on the under concave side. The disease proceeds from the stem into the leaves, the bases of which become discolored. In the stem the greatest injury is caused to the cambium layer, which shrivels up and separates from the wood. In the outer bark tissues between the decaying cells is formed a pseudo-parenchymatic cushion from which simple or often dichotomously branched hyphæ break out through the cuticle. These hyphæ are at first beaded and continuous, but later double septa appear at the constrictions. In the center of these septa is cut out a spindle-shaped piece of cellulose, the "disjunctor," which serves the purpose of separating the gonidia at maturity. The ends of the gonidia are at first incurved around these pieces, but when they separate the ends push out, making the gonidia lemon-shaped. The septa form parts of what the author calls the "primary membrane" of the spores, which forms just within the common cell-wall of the original beaded hypha.

The ripe, separated gonidia germinate very differently according to the medium in which they happen to be placed. In perfectly pure water the surface of the gonidium becomes covered with small, round spermatia-like sporidia, which are incapable of germination. In slightly impure water the gonidia put out short hyphæ, which in turn produce

and cut off these small bodies on all sides. In fresh juice pressed from a ripe plum the gonidia grow into branched, many-celled germ tubes, whose cells at once swell up into large spheres and easily anastomose. Finally, in plum and raisin decoction the gonidia produce long, separate, often anastomosing branched hyphæ, which when transferred into pure water again produce the globose sporidia, although they do not do so in the other media.

These gonidia are carried by the wind to the stigmas of the *Vaccinium* flowers, where they germinate. The germ tubes follow the path of the pollen tube, grow down into the ovary, and there develop into a sclerotium-forming mycelium. The cells of the ovary first become filled with a sclerotium-like mass, and the ends of the hyphæ form a palisade-like layer against the ovary wall. Later branches of the hyphæ break through into this wall and form a sclerotium there also. In the mean time some of the central portion has disappeared, so that the complete mature sclerotium is hollow and is composed of two layers, the inner one consisting of the palisade portion of the mass within the ovary cells, and the outer of the pericarp permeated by the fungous mass.

A sclerotium finally develops in every infected berry. Instead of ripening,the berries become dark colored, fall from the plant at the end of the summer, and remain under the snow without any noticeable change through the winter.

In the spring, just after the melting of the snow, primordia are produced somewhat below the rind of the outer layer. These do not always develop farther, more than one of them growing out into chestnut-brown, long-pedicelled, cup fruits only in occasional instances.

The apothecia are bell-shaped at first, later they are plate-like, and finally the edge sometimes turns downward. When the cup is fully formed a shaggy tuft of rhizoids grow out from the base of the stem; they serve the plant not only as a support but as an organ for obtaining nourishment.

The hymenium is composed of paraphyses and asci, the latter being formed from the primordia themselves and the former from outgrowths of the cells of the outer layer of the sclerotium. The paraphyses are fine, simple or dichotomously branched, septate hyphæ, whose upper free ends are slightly club-shaped and surrounded by a brown balsam-like mass. The asci always contain eight ascospores of nearly uniform size, all capable of germination.

Like the gonidia, the ascospores germinate differently according to the substratum in which they are sown. In pure water they also cut off small, globose, spermatia-like sporidia from their sides. In a plum decoction they grow out into long, irregularly formed threads, and swollen spherical protuberances. In a decoction of fresh leaves and young stems of the Cowberry the ascospores put out one or several fine germ tubes, between which and the globose sporidia almost all the intermediate stages can be found.

The ascospores infect the unfolding shoots of the Cowberry in the spring, about the end of May or beginning of June. At the point of contact with the host plant an ascospore puts out one, occasionally two, slender germ tubes, which never penetrate through a stoma but bore between two adjacent epidermal cells or directly through one of these into the host plant.

The germ tubes which are produced by the ascospores seek the fibro-vascular bundles of the host plant, and continue their growth from these bundles as a centre, thus reversing the direction of the fungus so that it grows from the center of the plant toward the periphery. Then appears a most peculiar phenomenon; the fungus exerts an injurious influence on the surrounding tissues of the host plant, killing them first and then using them as food for its further development.

Finally the hyphæ penetrate between the elements of the outer rind, which has been killed by the fungus, and there develop into a large-celled, pseudo-parenchymatic, stroma-like cushion, from which the gonidia chains grow into the air through the ruptured cuticle.

The other three species are dealt with much more briefly, since their general characteristics are much the same as the first one. In the chapters devoted to them the author deals mainly with the features which distinguish them as distinct species and wherein they differ from the first.

He suggests that the second species which attacks the small cranberry, *Vaccinium oxycoccus*, may be the same one that attacks the American cranberry, *V. macrocarpon*, and if this is true says that the matter of routing the disease is an easy one, viz, collecting and burning all the diseased berries in the fall. To one acquainted with the manner and places of growth of American cranberry vines this method might present some practical difficulties.

In conclusion there are a few notes on other forms.

He found the gonidia and a sclerotium-like condition of *Acrosporium cerasi*, Rabh., which occurs on the cherry. On *Prunus padus* he found a fungus having the three forms, gonidia, sclerotia, and apothecia, and analogous forms were observed on *Sorbus acuparia*. He is also of the opinion that the well-known *Monilia fructigena* is only the gonidial form of a similar Sclerotium. He has found Sclerotia in the fruit of *Alnus* and *Betula*, and in the latter case has seen a cup fruit grow from the Sclerotia in the spring.

The work is a valuable contribution to our knowledge of the life histories of the *Sclerotiniæ*, and the author's name is sufficient authority for its perfect reliability. The illustrations are particularly fine, and it is a deplorable fact that very few American works can point to similar ones.—EFFIE A. SOUTHWORTH.

JENSEN, J. L. Journal of the Royal Agricultural Society of England, Vol. XXIV., Part II. *The propagation and prevention of smut in oats and barley.*

This is the title of a paper which has been reprinted in pamphlet form from the journal of the Royal Agricultural Society of England. The paper is full of practical ideas, many of which are comparatively new, and deserves careful attention by all grain-growers.

The paper is divided into three parts: A. Propagation of smut; B. Varieties of smut; C. Prevention of smut. Under the first head Mr. Jensen states (1) The spores of smut falling on the ground during the summer will not to any appreciable degree affect barley and oats grown in that field in the ensuing season. (2) The spores of smut in farm-yard manure, when applied to the field, will not to any appreciable extent affect oats and barley. (3) Spores of smut adhering externally to the seed of barley and oats are unable, to any appreciable degree, to infect the crop produced from that seed. (4) Although, as is shown by the foregoing, it is impossible to infect oats and barley with smut spores to any appreciable extent by applying them to the seed, yet there can be no doubt that the spores are the reproductive bodies of the fungus by which smut is propagated in nature.

The first three statements are supported by statistics of experiments in which seed was sown in soil containing smut spores, in heavily manured soil, and with spores dusted on the outside of the *seed; in no case was there an appreciable increase in the amount of smut.* Under 4, Mr. Jensen attempts to answer the question, "In what manner does the propagation of smut take place?" His experiments led him to the following solution of the question: Infection takes place by means of spores which, having gained admission within the husk, remain there quiescent until the grain germinates.

Under B is given the results of experiments to determine whether or not the smut which affects barley, oats, and wheat are the same species. The author concludes from these trials that if these smuts are not different species they are at least well marked varieties. He further remarks that to the farmer this information is of importance, as there is no fear of adjacent fields sown with different crops infecting one another; a smutted barley field, for instance, will not infect a field of oats, or *vice versa.*

C. *Prevention of smut.*—The various dressings, such as sulphate of copper in solution, solution of sulphate of copper with quicklime applied about twelve hours afterward, sulphuric acid and water, quicklime with or without subsequent treatment with common salt are first enumerated under this heading. The author then gives the results of his experiments with these preparations as well as with several methods of his own conception, which consisted in exposing the grain to dry and moist heat, also soaking it in water ranging in temperature from 123° to 133° Fahr.

Concerning the action of sulphate of copper (bluestone) Mr. Jensen says that one-fourth per cent. of this salt reduced the per cent. of smutted heads to such an extent that it might be considered practically sufficient. A part of the seed-crop was killed, however, and the crop suffered not inconsiderably. With a 1 per cent. solution about three-fourths of the seed was killed, and a large number of plants remained without rootlets for two or three weeks. This lot was still green when all the others were almost ripe. The remaining experiments demonstrated beyond question that the seed in many cases was destroyed or its vitality was greatly injured by dressing with the preparations enumerated above; they moreover showed that disinfection by heat was the safest and most satisfactory way of treating the grain. The author concludes his remarks on this subject as follows:

Dressing cereals with sulphate of copper in the usual manner against smut and bunt causes, as a rule, a waste of seed. It is, moreover, injurious to the plants and is unnecessary. Treating the seed with water heated to a temperature of 127° Fahr. for five minutes prevents these diseases equally well and protects barley much better, while it has the advantage of not injuring the seed or the resulting crop.—B. T. GALLOWAY.

KELLERMAN, W. A. Experiment Station, Kansas State Agricultural College. Bulletin No. 5, Dec., 1888. *Preliminary Report on Sorghum Blight.*

The paper describes the appearance of the disease, and gives briefly the results of the laboratory experiments, which were performed by W. T. Swingle.

Plants were examined first with reference to the disease being caused by insects and the theory disproved.

The most common and evident appearance of the disease is in large blotches on the leaves. The roots were examined and found to be diseased also, often to such an extent as to be entirely destroyed, and in this case the stem at the junction of the roots was also diseased; in other cases the stem was intact, except where it had been wounded.

The microscopic examinations resulted in proving the disease to be the work of a micro-organism, the *Bacillus sorghi*, belonging to the group of *Bacteria*. The presence of the germ was demonstrated by the microscope, and the disease was produced on young and apparently healthy plants by inoculating them with a broth containing the organisms.

Sorghum seed was planted at the same time in soil taken from a field of diseased plants and in soil from the greenhouse. The plants which were produced in the former were all badly diseased, and those in the latter not at all or only slightly.

He concludes (1) that it is not wise to use a field in which the disease has been present even in a mild form the year before; (2) when the crop is infected, not even the stubble should be plowed under but collected and burned.

A list of varieties which are free from or subject to attack is also given. The paper is one of great practical value to sorghum growers.—EFFIE A. SOUTHWORTH.

MASSEE, GEORGE. *On the presence of sexual organs in Æcidium.* Annals of Botany, Vol. II, No. V, p. 47.

There has been much speculation among botanists as to the occurrence of antheridia and oögonia in the *Uredineæ.* The question now seems in a fair way to be settled in the affirmative.

In *Annals of Botany* for June, 1888, George Massee, of Kew, contributes an interesting illustrated paper, going to show that a distinct sexual process precedes the formation of Æcidia in this important group of plants. His discovery was made in the spring of 1888, while examining the æcidial form of *Uromyces Poæ*, Rab., which form occurs abundantly at Kew on *Ranunculus Ficaria.*

He describes and illustrates several stages. Fig. 1 shows a clavate body surrounded by a weft of hyphæ. This body, rich in granular protoplasm, was under observation some days, during which its size increased and its contents became less granular. Several refractive globules also appeared, and a nucleus was demonstrated by use of methyl-green. Fig. 2 shows an irregular oblong body much larger than Fig. 1, but otherwise resembling it; and a much narrower, curved, and blunt-pointed antheridial body arising from a distinct mycelial thread and attached by its end to the side of the oogonium. Its exact connection with the latter was not made out. Both organs are full of densely granular protoplasm, and each is separated from its hypha by a septum. By keeping this slide in water with 2 per cent. of glycerine the development of these organs was followed for two days. During this time the antheridium became empty and shriveled, while the oogonium continued densely protoplasmic, increased in size, and became somewhat pear-shaped—Fig. 3. The hyphæ beneath and around the oogonium also became much branched, forming a complex weft. Fig. 4 shows a state much further advanced, the oogonium having become nodulose, and more nearly like an ordinary æcidium. These nodules, with exception of the basal row, which forms the peridium, are said to grow into the ordinary basidia of the æcidium. It does not appear that Mr. Massee was able to trace Fig. 3 directly into Fig. 4.

For the benefit of those who wish to make observations on other æcidia it should be stated that in the æcidium on *Ranunculus ficaria* this stage was found to be very fleeting. By the time the æcidia became visible all trace of it had disappeared. Sections through the leaves should be made when the spermogonia first appear, or while the future æcidium is indicated only by the faintest discoloration.—ERWIN F. SMITH.

Prillieux.—*Périthèces du Black-Rot.* Société Mycologique de France, tome IV, 2e fascicule, 1888, p. 60.

Tome IV of the reports of the Société Mycologique contains a paper by M. Ed. Prillieux upon the *Perithecia of the Black-rot* of grapes, in which there are several points worthy of special note. Prellieux believes that the pycnidia and spermogonia are changed into perithecia during the winter. After the asci had developed he found the mouth of the perithecia filled with a plug of gelatinous matter, probably composed of the remains of a layer of delicate parenchyma that bore the stylospores toward the end of summer. As the asci grow they push up this mass. The apex of the ascus is very slightly thicker than the rest of the walls, and probably becomes gelatinized when the end of a spore presses against it. In many cases, however, no opening is made, but the spores remain surrounded by a mucilaginous substance until the walls of the ascus disappear; undoubtedly the gelatinization of the apex has extended to the entire membrane. When the spores have become detached from this mass, a particle of transparent, gelatinous substance was seen attached to one end, probably for the purpose of fastening them to the leaves.

On the surface of berries which had passed the winter in the open air was found a dark-colored mycelium creeping over the cuticle and occasionally bearing spores on branches upright to the surface. Prillieux merely mentions their presence, and says he can not decide without further evidence as to whether they are part of the *Physalospora* or are some foreign fungus.—Effie A. Southworth.

MM. Pierre Viala et L. Ravaz. *Recherches expérimentales sur les maladies de la vigne.* Comptes Rendus, tome CVI, juin 18, 1888, *p.* 1711.

The *Comptes Rendus* contains a paper by Pierre Viala and L. Ravaz, read before the *Académie des Sciences* in June, 1888. It comprises a review of the main results of their experiments on the diseases of the vine.

The proof of the genetic relationship between the different forms of black rot and between the fungus on the leaf, stem, and fruit is noted. They also record the finding of the Perithecia in France, and state that they are either developed from pre-existing pycnidia or produced directly from mycelium filaments.

Besides the notes upon Black-rot, there are some on White-rot, Anthracnose, and Mildew. White-rot was produced on healthy leaves, stems, and berries by sowing the spores of *Coniothyrium*, thus showing the parasitism of the fungus, and that it was reproduced by stylospores.

The mycelium of Anthracnose was observed in the stems in a latent condition during the winter, and the formation of conidia from the same mycelium seen the following spring.

The identity of *Oidium Tuckeri* with the conidial form of *Uncinula spiralis* was established by comparison of specimens from France and America.—EFFIE A. SOUTHWORTH.

BRIOSI and CAVARA. *Funghi parassiti delle piante coltivate od utile, essiccati, delineati e descritti.* The parasitic fungi of cultivated and useful plants. Specimens, illustrations, and descriptions.

G. Briosi and F. Cavara, the managers of the Cryptogamic Laboratory at Pavia, Italy, anticipated the first fascicle of their collection and descriptions of the parasitic fungi of cultivated and useful plants by a circular letter to possible subscribers, in which they state that the reasons which led them to make the collection was to place in the hands of farmers, schools, and agricultural colleges a publication which will present the necessary elements for the easy determination of the parasites infecting plants of economic value.

This publication, they say, will consist of (1) specimens of plants attacked by parasitic fungi; (2) a drawing of the parasite and its organs of reproduction; (3) a short and accurate description of the fungus, accompanied by an indication of the remedies that have been sanctioned by experience.

They state that this is the first publication of the kind that has ever been issued, and while its preparation requires no small amount of labor, it is undertaken in the hope that it will prove of practical value.

The first fascicle has already been received by the Section, and proves to be all that was promised in the circular letter. The drawings are not elaborate, but clear, and convey a distinct idea of the fruit of the fungus, and these, combined with the descriptions and actual specimens, furnish sufficient data for the determination of any species contained in the collection.

The text is Italian, and this will hinder many who are directly interested in agriculture from obtaining much profit from the work; but the species comprised in the first fascicle are mainly those which are common in America as well as in Italy. It seems to us that a good translation would be of great practical value. There are twenty-five species in a fascicle, and each fascicle costs 7 lire in Italy and 8 ($1.57) in other countries. They are sent post paid, neatly put up.—EFFIE A. SOUTHWORTH.

WARD H. MARSHALL. *A Lily disease.* Annals of Botany, Vol. II., No. VII, pp. 319–382, with five double plates, 60 figures.

This paper is an important contribution to our knowledge of the biology of the form-genus commonly called *Botrytis*.

Professor Ward has demonstrated that a *Botrytis* of the *Polyactis* type, found for a number of years on the spotting and rotting stems, leaves, and flower buds of *Lilium candidum*, is a true parasite and the cause of the disease. He established the uniform connection of the fungus with

the spots; produced the disease in healthy lilies by sowing conidia in drops of water on their surface; and finally saw the penetration of the germ-tube and the development of the mycelium within the tissues.

This fungus is also capable of living as a saprophyte. Many interesting cultures were made, the most important discovery being that its mycelium secretes a ferment similar to that discovered by DeBary in *Sclerotinia sclerotiorum* and capable of dissolving cellulose. This ferment is frequently excreted from the hyphæ ends in the form of small yellowish drops. When fragments of lily tissues are thrown into this liquid the cellulose walls become swollen and soft and the middle lamella disappears. Pasteur's solution, in which the fungus had been grown, produced the same effect, as did also water in which a mass of the mycelium had been bruised. Portions of the same solutions after two minutes' boiling produced no effect whatever. Evidently the boiling destroyed or dissipated the active substance. By addition of alcohol Professor Ward succeeded in obtaining a white flocculent precipitate which, when redissolved in water, produced the same effect as the excretion itself. "The middle lamellæ of all the parenchyma cells were destroyed and the cells isolated as if they had been boiled, while the cellulose walls swelled up and became distinctly lamellated and folded." He believes this white precipitate consists chiefly of a ferment related to a zymase, but he has not been able to isolate it perfectly. To its presence the hyphæ ends owe their remarkable power of boring through cellulose walls, which he observed repeatedly. The wall in front of the advancing hypha becomes swollen, softened, and finally dissolved. The rapidity with which this takes place is sometimes remarkable. In one instance it was completed in 10 minutes, in another, in 30 minutes. He thinks the irritation of contact induces a more copious production of this ferment, the extrusion of which he observed in many instances where the hyphæ ends touched the sides of flasks or the surface of slides and cover-glasses.

Another curious fact, often noticed, however, by other observers, was the anastomosing or conjugating of hyphæ. This was astonishingly frequent in cultures after the first two days, the mycelium becoming a perfect net-work by means of cross-connections. In some instances Professor Ward observed a hypha end move through an arc of more than 90 degrees for the purpose of uniting with another, and, as he remarks, "it is difficult to avoid the impression that the two or more bodies concerned are attracting one another in some way." He thinks the softening and disappearance of the hyphæ walls to form such unions is due to the presence of the previously mentioned soluble ferment. He also inclines to believe that the softening of walls, due to the localization of this ferment in given portions of the mycelium, is what determines branching. This, however, is theoretical. Mere contact of hyphæ does not always lead to their union, and it is suggested that this anastomosing may be the result of an effort "to equilibrate certain

differences which have unavoidably made themselves apparent in the metabolic processes."

Professor Ward was not able to establish the connection of this fungus with any other form, but believes it to be the conidial state of some *Peziza*, of which there would seem to be little doubt.—ERWIN F. SMITH.

EXPLANATION OF PLATES.

PLATE I.

Figs. 1–11. *Tilletia buchloëana*, Kell. & Sw. on *Buchloe dactyloides.*

1–4. Affected ovaries of various sizes, x 6.

5. A spore showing sub-reticulate markings, and pedicel of attachment (?), x 500.

6. Spore showing unusually prominent spines and two layers of the hyaline envelope, x 500.

7. An optical section of an immature spore showing the two layers of the hyaline coat; the inner extending from the wall to the tips of the spines; the outer spinose and inner lighter thinner wall; the granular layer, and the collapsed center, x 500.

8–10. Optical sections of mature spores showing but one hyaline layer; Fig. 9 shows the rudiment of the pedicel of attachment (?), x 500.

11. A male spikelet consisting of three flowers all bearing ovaries which are filled with the mass of spores.

Figs. 12–25, *Ustilago Andropogonis*, Kell. and Sw. on *Andropogon provincialis* (Figs. 12–18 on *A. provincialis*) and *A. Hallii*, Hack.

12–14. Affected ovaries of various sizes, x 3.

15. A portion of the rachis showing a normal sessile, and a pedicelled flower, also an extra short pedicelled one which (like the sessile one) bears an infested ovary, x 3.

16. A portion of the rachis bearing normal flowers, the sessile pistillate and affected, the pedicelled one staminate and free from the disease.

17. Two spores of *Ustilago andropogonis* from *A. provincialis* seen in optical section showing spines, thickness of cell-wall, and granular contents, x 500.

18. Three spores of same showing common sizes and shapes, x 500.

(Figs. 19–25, *Andropogon Hallii.*)

19–22. Affected ovaries of various sizes, x 3.

23. A portion of the rachis bearing sessile (fertile) and pedicelled (normally sterile) flowers, both producing smutted ovaries.

24. Three spores of *Ustilago andropogonis* from *A. Hallii*, showing common sizes and shapes, x 500.

25. Two spores seen in optical section showing thickness of cell-wall and granular contents, x 500. As will be seen by comparison with Fig. 17 the spores from *A. Hallii* had a slightly thicker wall than those from *A. provincialis.*

Figs. 26-40. *Ustilago boutelouæ*, Kell. & Sw. on *Bouteloua oligostachya.*

26–28. Affected ovaries of various sizes, x 6.

29. An affected spikelet distended and the palet split by the enlarged smutted ovary, x 6.

30. Six spores showing common sizes and shapes, x 500.

31. Three spores seen in optical section showing spines, thickness of wall and slightly granular and guttate ? contents, x 500.

(Figs. 32–40 showing germination of spores of *Ustilago bouteloucæ* in distilled water on slide in damp chamber 24 hours at 37° C.; collected December 20, 1888, germinated February 20, 1889.)

32. Spore showing cleft in the wall and young promycelium, x 500.
33. Spore bearing a branched promycelium which has split the cell-wall and about to produce a sporidium on the side (?), x 500.
34. Spore showing two promycelia, the one scarcely developed, x 500.
35. Spore seen in optical section showing a slender promycelium apparently connected with the contained gutta, x 500.
36. A spore with a more mature promycelium which is either branched and bearing a sporidium at the end of the branch, or a primary sporidium is producing a secondary one, x 500.
37. A free sporidium budding, x 500.
38. A promycelium broken off from the spore, bearing two sporidia from below the septa, x 500.
39. A free promycelium bearing a single sporidium, x 500.
40. A slender free promycelium producing a single sporidium, x 500.

Plate II.

Fig. 1. Cross-section of cells of normal ground tissue; *a*, intercellular spaces.

2. Longitudinal section of cells of normal ground tissue.
3. A section of a portion of the normal epidermis with the underlying parts; *a*, epidermal cells; *b*, sub-epidermal layers; *c*, cells of the ground tissue.

Plate III.

4. Cross-section of a normal fibro-vascular bundle; *a*, intercellular canal; *b*, annular vessel; *c*, pitted ducts; *d*, phloëm; *e*, elements of the bundle sheath.
5. Longitudinal section of a normal bundle; *a*, cells of ground tissue; *b*, elements of bundle sheath; *c*, cambiform cells; *d*, sieve tubes; *e*, tracheid; *f*, portions of an annular vessel; *g*, intercellular passage; *h*, wood parenchyma.

Plate IV.

6. Longitudinal section of normal epidermis; *a*, large; *b*, small cells of epidermis; *c*, sub-epidermal cells.
7. Surface view of normal epidermis; *a*, large; *d*, small cells; *b*, guard cells; and *c*, accessory cells of the stomata.
8. Diagram of a section of a stem with the abnormal growth; *a*, *b*, stem; *c*, abnormal growth; *e*, bundles; *d*, region of active growth. The light shading represents ground tissue cells, the dark shading masses of spores, and the lines in *c* the bundles sent out to the abnormal growth.
9. Section similar to that represented in Fig. 3, except that it is slightly distorted; *a*, epidermal and sub-epidermal layers; *b*, ground tissue cells; *c*, portion of a bundle.
10. Surface view of epidermis of abnormal tissue; *a*, epidermal cell; *b*, nucleus.

11, 12. Surface view of abnormal tissue showing distortion of stomata; *a* guard, cells; *b*, accessory cells; *c*, epidermal cell.

Plate V.

13, 14. Surface view of abnormal tissue showing distortion of stomata; *a*, guard cells; *b*, accessory cells; *c*, epidermal cell.

15. Cross-section of cells of abnormal ground tissue in region of active growth, showing nucleii.

16. Cross-section of the same a little nearer the periphery nucleii not so conspicuous, and are not represented.

17. Cross-section of the same still nearer the periphery.

Plate VI.

18. Cross-section of the same near the periphery with *a*, the epidermal cells.

19. Cross-section of a distorted bundle; *a*, intercellular canal; *b*, annular vessel; *c*, pitted duct; *e*, element of bundle sheath; *f*, wood parenchyma.

Plate VII.

20. A section in abnormal tissue showing *a*, longitudinal section of a bundle, also a mass of mycelium filaments in early fruiting stage.

21. Longitudinal section of a more typical abnormal bundle; *a*, branch of the bundle.

22. Cross-section of the abnormal bundle.

23. Mycelium filament.

24. Mycelium filaments running through cells of the ground tissue.

25. Early stage of spore formation.

26. Later stage of spore formation.

27. Mature spore.

— = .01^{mm}, scale to which the figures are drawn.

Plate VIII.

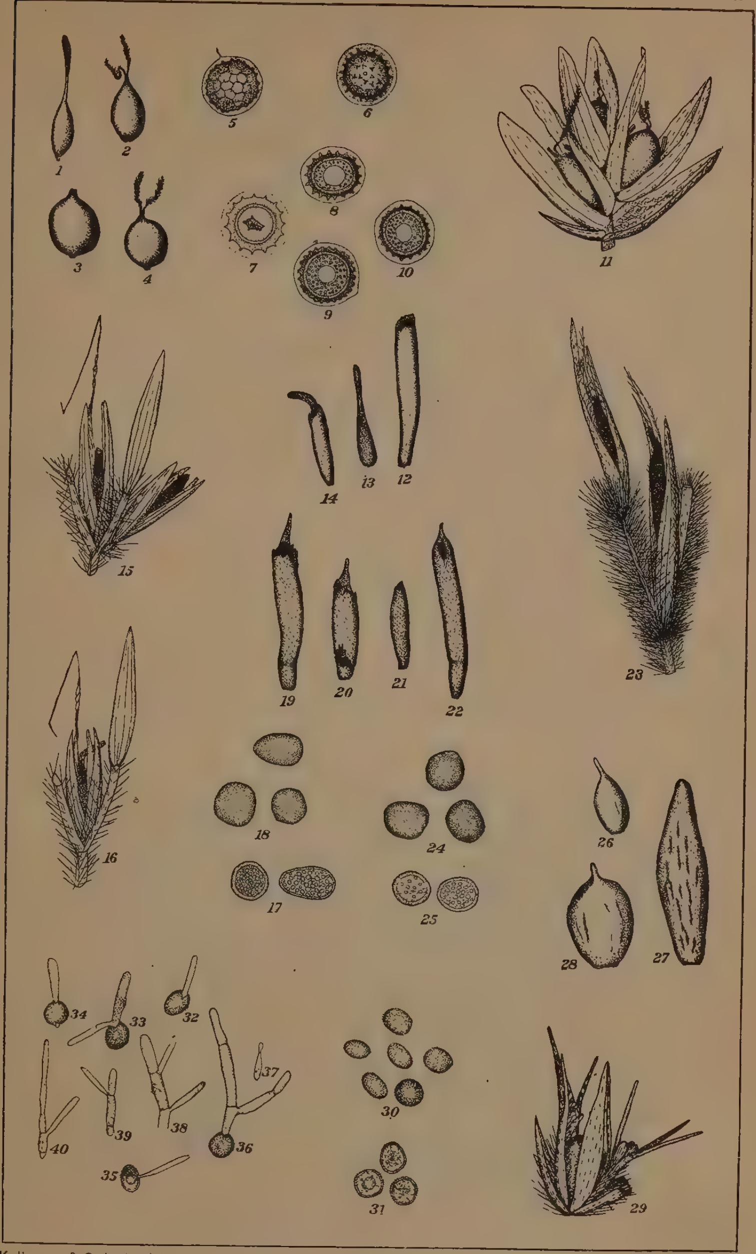
Fig. 1. Upper surface of pileus of *Mucronoporus tomentosus*, Fr.

2. Lower surface of same.

3. Section of pores showing the projecting points or spines.

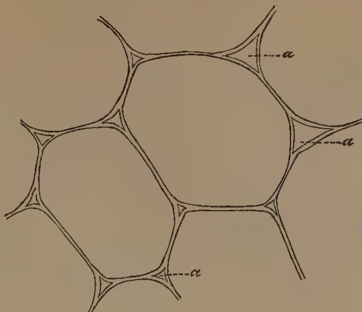
4. One of these spines more highly magnified.

5. Spine with a bifid tip.



Kellerman & Swingle, del.

KELLERMAN AND SWINGLE ON NEW SPECIES OF KANSAS FUNGI.



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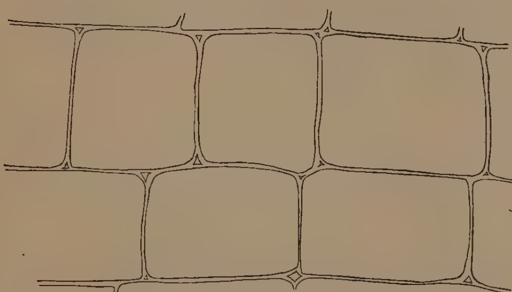

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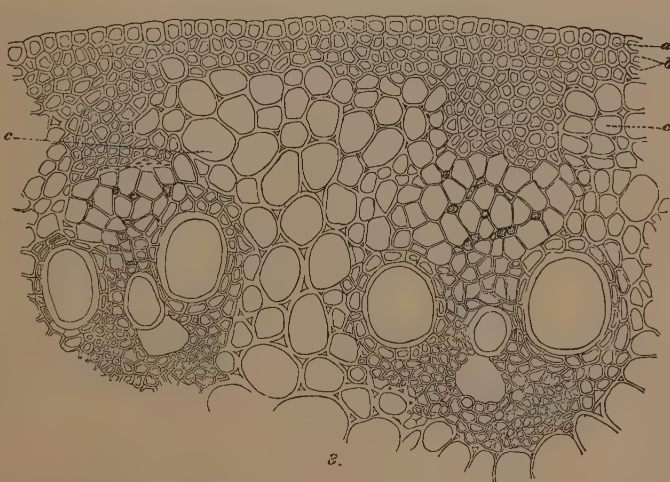

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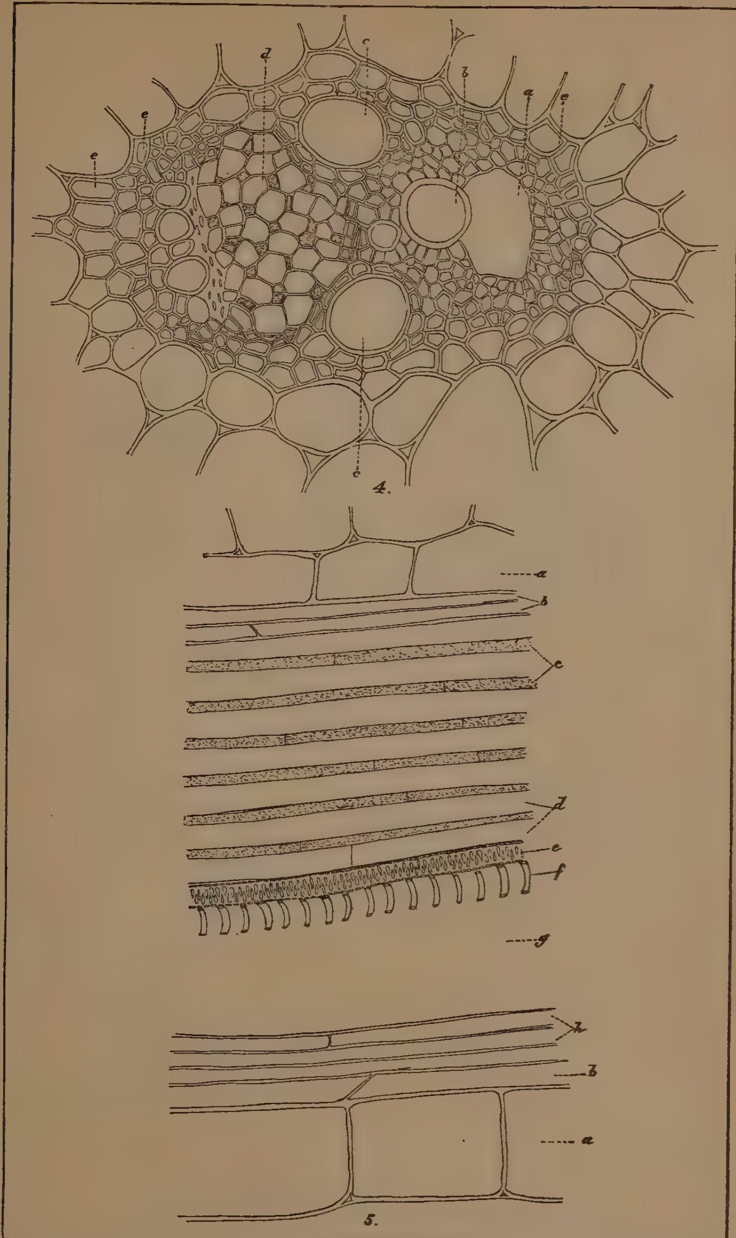
F. L. Knowles, del.

KNOWLES ON USTILAGO ZEÆ-MAYS.



E. L. Knowles, del.

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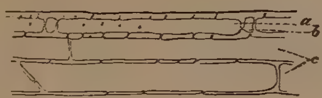

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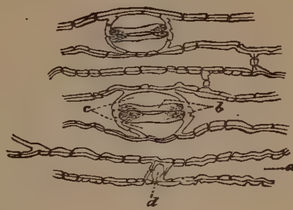

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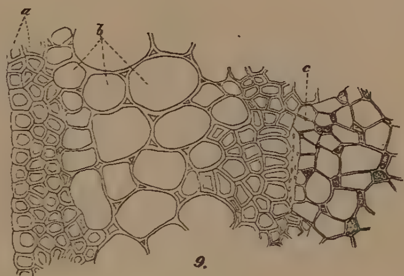

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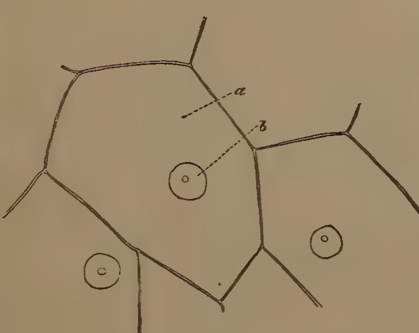

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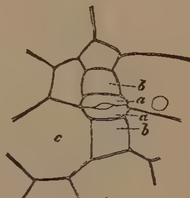

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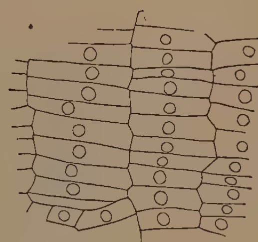

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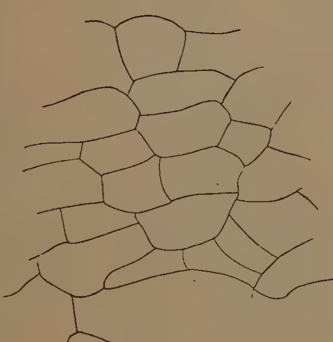

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17.

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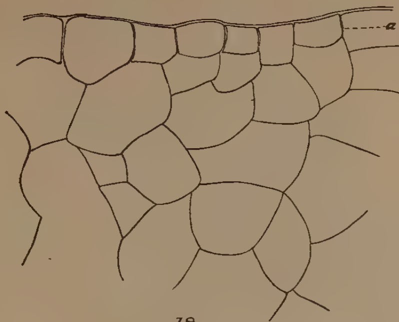

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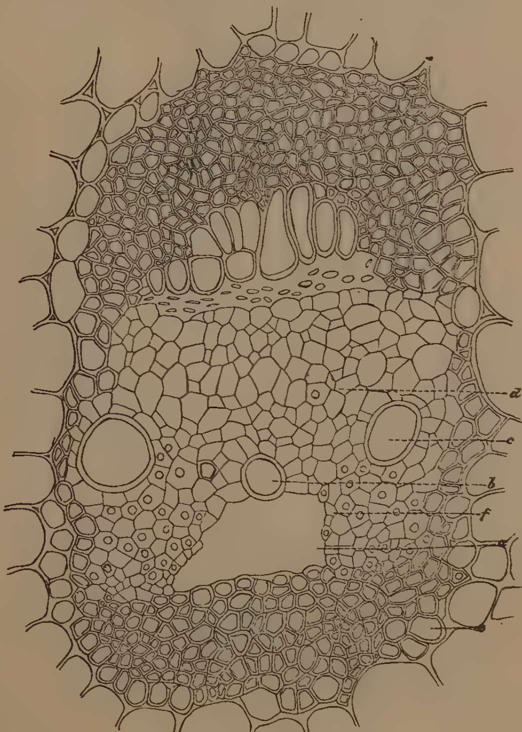

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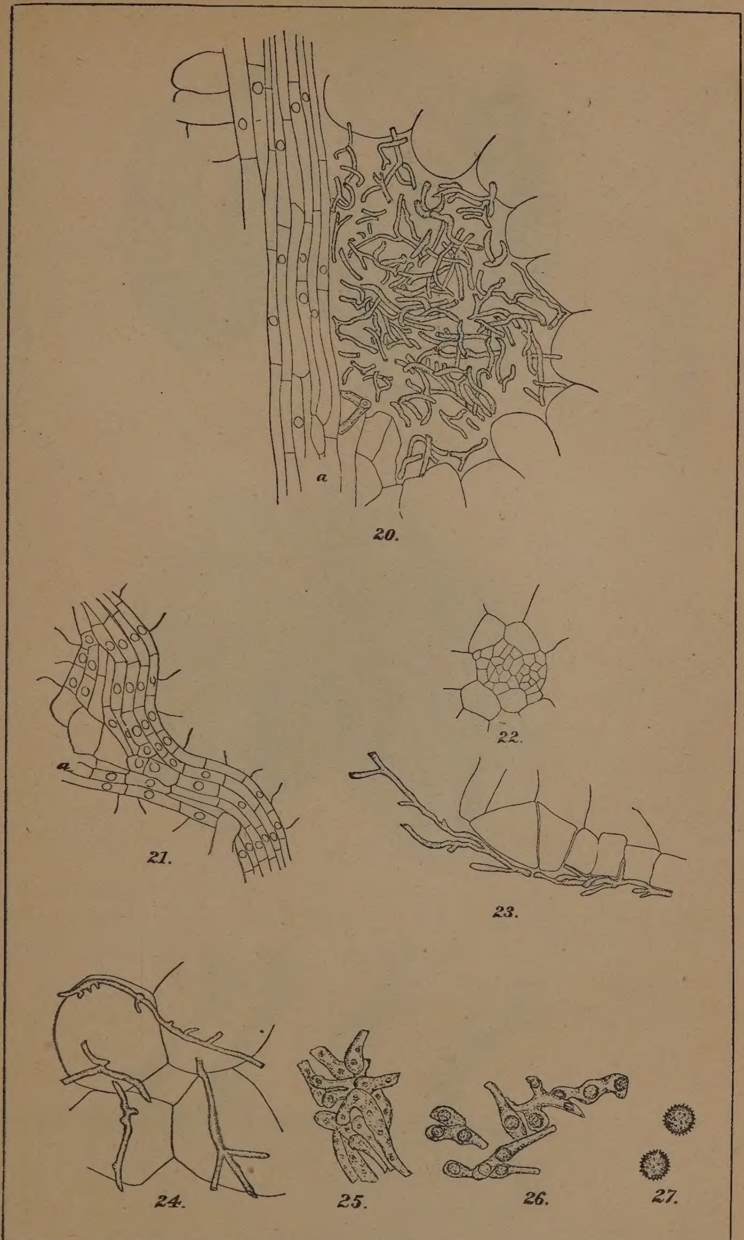

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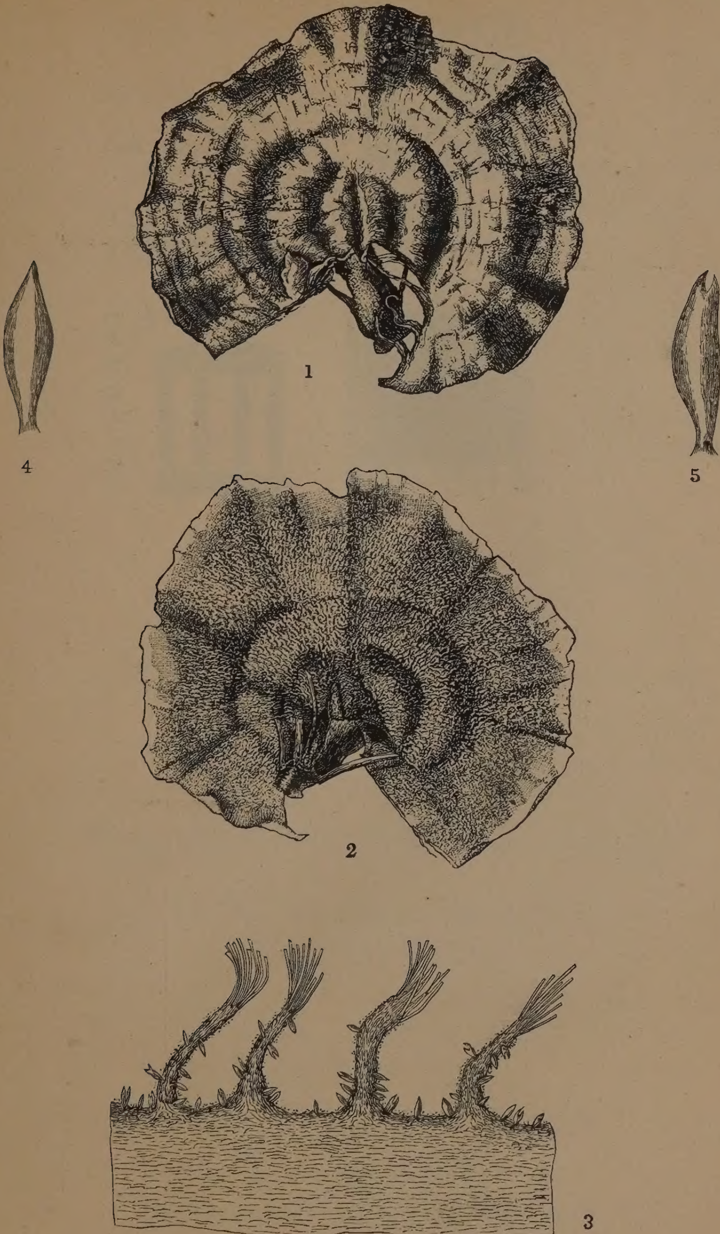
PLATE VIII.



Sc.

Roberta Cowing del.

ELLIS ON MUCRONOPORUS TOMENTOSUS, FR.